LIBRARY DEC 12 1944

Volume 18 NOVEMBER, 1944 Number 6

JOURNAL OF PALEONTOLOGY

A publication of The Society of Economic Paleontologists and Mineralogists *and* The Paleontological Society *with the generous support and cooperation of* The American Association of Petroleum Geologists *and* The Geological Society of America

CONTENTS

The Permian of southernmost Mexico and its fusulinid faunas ..... *M. L. Thompson and A. K. Miller* 481

Ostracoda from the Duplin marl (Upper Miocene) of North Carolina ..... *Richard A. Edwards* 505

Auloporidae and Hederelloidea ..... *Maxim K. Elias* 529

Hederella and *Corynotrypa* from the Pennsylvanian ..... *G. E. Condra and M. K. Elias* 535

Fossiliferous Ordovician in lowlands of eastern Peru ..... *Norman D. Newell and Isaac Tafur* 540

A new Paleocene catometope crab from Texas, *Tehuacana tehuacana* *H. B. Stenzel* 546

A new Cretaceous crab, *Graptocarcinus muiri*, from Mexico ..... *H. B. Stenzel* 550

Paleoecology of three faunules in the Permian Kaibab formation at Flagstaff, Arizona ..... *David Nicol* 553

PALEONTOLOGICAL NOTES

Authorship and genotype of *Schizodus*, a Late Paleozoic pelecypod ..... *David Nicol* 558

New names for two foraminiferal homonyms ..... *Helen Tappan* 560

Reklaw Ostracoda: a correction ..... *Morton B. Stephenson* 560

Distribution of *Escharapora hogbeni* Fritz ..... *Marshall Kay* 560

EDITORS

C. WYTHE COOKE, for the Paleontological Society.

J. MARVIN WELLER, for the Society of Economic Paleontologists and Mineralogists.

The JOURNAL OF PALEONTOLOGY is published bi-monthly. The numbers issued in January, May, and September are sponsored by The Paleontological Society in cooperation with The Geological Society of America; those issued in March, July, and November are sponsored by The Society of Economic Paleontologists and Mineralogists in cooperation with The American Association of Petroleum Geologists.

The subscription price of the JOURNAL OF PALEONTOLOGY is $6.00 per year prepaid to addresses in the United States.

Single numbers, $2.00 each.

Postage is charged extra for all other countries in the Postal Union, 40 cents on annual subscriptions (total $6.40).

The JOURNAL will furnish reprints at cost. Orders should accompany manuscript.

Communications about the JOURNAL, subscriptions, rates, memberships, change of address, and nonreceipt of preceding numbers should be addressed to Society of Economic Paleontologists and Mineralogists, P. O. Box 979, Tulsa 1, Oklahoma. Claims for nonreceipt of preceding numbers must be sent in within three months of the date of publication in order to be filled gratis. Communications in regard to advertising should be addressed to J. Marvin Weller, Illinois Geological Survey, Urbana, Ill.

Communications in regard to manuscripts or purely editorial matters should be addressed to J. Marvin Weller, Illinois Geological Survey, Urbana, Ill., or to C. Wythe Cooke, U. S. National Museum, Washington, D.C.

Contributors are requested to instruct their photographers to illuminate fossils from the upper left side, the conventional manner. Plates normally should be arranged for publication at the size of 5¼ by 7½ inches, exclusive of margins, heading, and title. Printed numerals of standard size and form may be obtained free from either editor. When requesting them state number of plates and the dimensions of each plate.

Entered as second-class matter at the Post Office at Tulsa 1, Oklahoma, under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in paragraph 4, section 538, P. L. and R., authorized April 3, 1935.

Additional entry as second-class matter at the Post Office at Menasha, Wis.

GEORGE BANTA PUBLISHING COMPANY, MENASHA, WIS.

JOURNAL OF PALEONTOLOGY

A publication of THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS *and* THE PALEONTOLOGICAL SOCIETY *with the generous support and cooperation of* THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS *and* THE GEOLOGICAL SOCIETY OF AMERICA

VOLUME 18 NOVEMBER, 1944 NUMBER 6

THE PERMIAN OF SOUTHERNMOST MEXICO AND ITS FUSULINID FAUNAS

M. L. THOMPSON AND A. K. MILLER
Lawrence, Kansas, and Iowa City, Iowa

ABSTRACT.—The Late Paleozoic strata of southern Chiapas, all of which are referred to the Permian, consist chiefly of sandstones, shales, and limestones. They are divided into four formations: the Santa Rosa? (1000 ft.+), Grupera (400 ft.), La Vainilla (300 ft.), and Paseo Hondo (475 ft.). The age of the first (oldest) of these is somewhat uncertain and it has yielded no significant fossils in Chiapas; the second is approximately equivalent to the Hueco and Wolfcamp of west Texas; the third seems to be younger than the Wolfcamp and older than the Leonard; and the fourth carries a characteristic Leonard fauna. Altogether the last three of these Chiapas formations have yielded 12 species of fusulinids, all of which are new but several of which are very similar to North American species. These fusulinids belong in the following genera: *Schubertella, Nankinella?, Staffella, Eoverbeekina, Schwagerina, Paraschwagerina,* and *Parafusulina,* each of which is discussed at some length in this report. *Schwagerina* is represented in all three formations; but *Paraschwagerina* was found in only the La Vainilla, and the other genera listed are known from only the Paseo Hondo.

IT HAS BEEN known for about fifty years that in Central America fossiliferous Late Paleozoic strata outcrop in a narrow belt extending east from southeastern Chiapas (southernmost Mexico) across the central part of Guatemala. Several authors have published in regard to these beds. However, there has been considerable difference of opinion as to their age, and the literature contains little information as to their exact nature. Most of the published data were obtained by Karl Sapper during the last ten years of the past century, though fairly recently the available information was summarized and reinterpreted by Schuchert (1935) and Sapper (1937). These summaries served to emphasize the need for additional observations.

Through the generosity of Mr. F. O. Thompson of Des Moines, we were able to spend several weeks in this region during the last part of 1940. Dr. F. K. G. Müller-ried of Mexico City, who had previously worked in Central America several times, kindly accompanied us, and we wish to acknowledge our indebtedness to both him and Mr. Thompson, as well as to the New Mexico School of Mines and the State University of Iowa, which granted us leaves of absence.

Most of our time in the field was spent studying and collecting from the fossiliferous Paleozoic limestones and shales which outcrop in southeastern Chiapas between La Vainilla, Chicomuselo, Comalapa, and Paseo Hondo (fig. 1). In this area we obtained thirteen collections of fusulinids, and a good many corals, bryozoans, brachiopods, pelecypods, and gastropods. The present report is confined to the fusulinids as Dr. Müller-ried is to publish an account of the other fossils.

Altogether our collections from Chiapas contain representatives of 12 species of

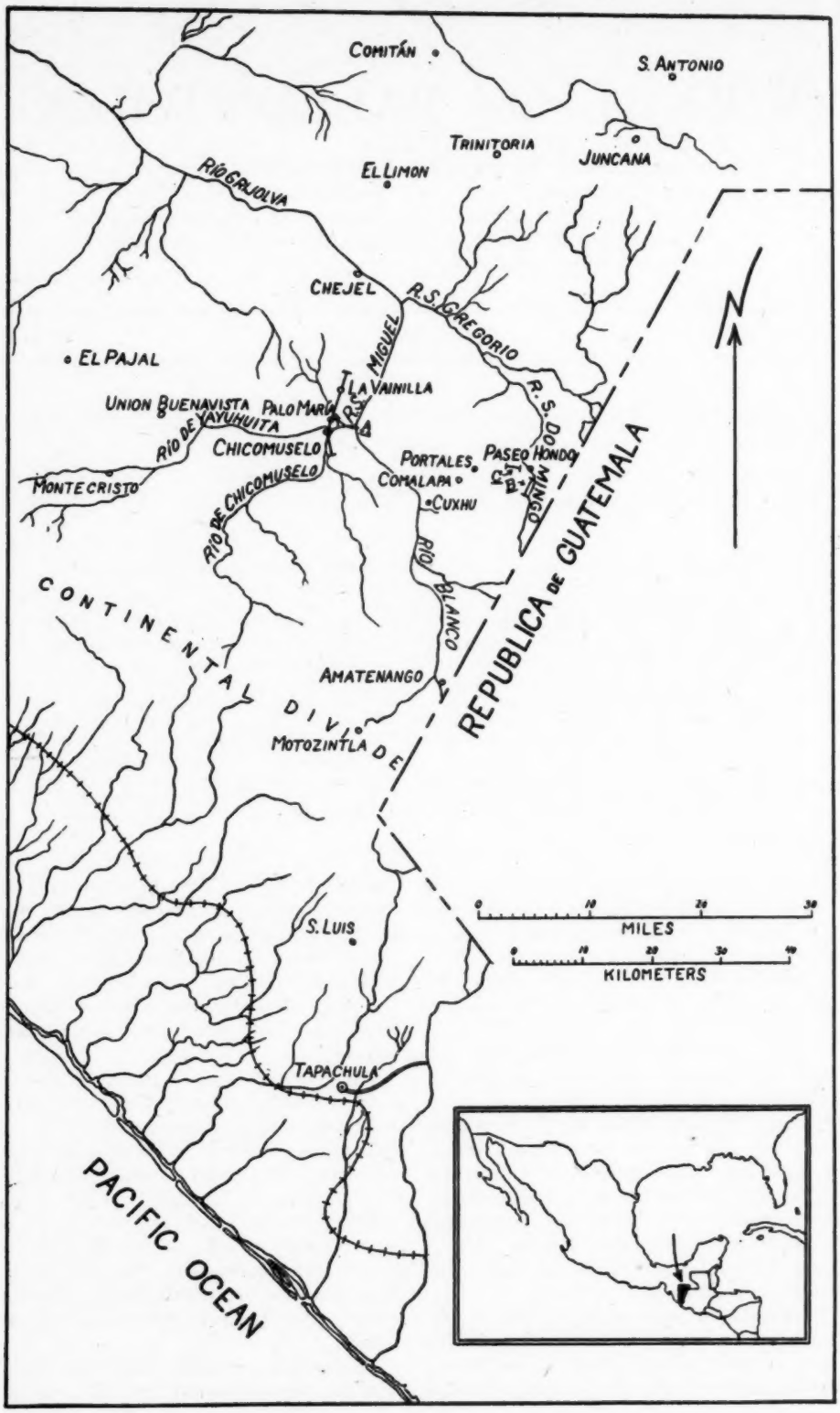


FIG. 1.—Locality map of southern Chiapas.

fusulinids. Although none of these is identical with forms described previously from other areas, several of them are so similar to well known North American species that they suggest tentative correlations.

PREVIOUS WORK

One of the earliest reports on the Palezoic strata of Central America was published by Dollfus and de Mont-Serrat in 1868. They applied the name "Santa Rosa" to a thick sequence of clastic beds that overlie the "crystalline complex" in central Guatemala and extend westward into Chiapas. This formation consists chiefly of red conglomerate and sandstone and variegated shale, and it is estimated to attain a thickness of as much as 3,250 feet (Schuchert, 1935, p. 330). It has long been regarded as Carboniferous in age, but Schuchert, after carefully reviewing all of the evidence, including a study of new collections and a restudy of some of the old ones, has recently concluded that it is "almost certain that much or all of the Santa Rosa is also Permian." This conclusion seems to have been based to a considerable extent upon the identification by Dunbar of Permian fusulinids in a collection which Powers made from beds believed to be in the upper part of the Santa Rosa near Pancajche, Guatemala. Insofar as we have been able to ascertain, no fossils have been reported from the lower part of this thick formation.

Paleozoic fossils appear to have been cited from Chiapas for the first time in 1894. In that year Sapper stated that in limestones outcropping near La Nueva and Tres Cruces he had found "*Productus semireticulatus?*" and "*Pleurotomaria* sp.?" together with other unidentified species of brachiopods and gastropods. At the same time he listed a variety of marine invertebrates, including fusulinids, from what he believed to be approximately equivalent beds in Guatemala —his indentifications were made in Germany by Zittel, Stolley, and Roemer, who seem to have regarded all of the Paleozoic fossils Sapper sent them as Carboniferous in age. Two years later, Sapper (1896, p. 4) added corals, fusulinids, and crinoids to the types of Paleozoic fossils known from Chiapas. A few of his specimens were deposited in Mexico City, and they have been listed by Aguilera (1897, 1907) and later Böse (1905). These authors also reported on material that Goyzueta collected from the same general horizon and locality during a survey of the Mexican-Guatemalan border, and like Sapper and his colleagues they believed the containing rocks to be Carboniferous in age.

In the Chiapas collections studied by him, Aguilera (1897, p. 200) identified, among other things, "*Fusulina granumavenae?* F. Roemer," a species which Sapper (1894, p. 8; 1894, p. 202; 1899, p. 64) lists from Guatemala. In 1912 Staff described and illustrated as *Fusulina verneuili sapperi* Staff one of the fusulinids collected by Sapper in Guatemala—this form clearly belongs in the Permian as it is now defined. Recently Dunbar (1939) restudied some of Sapper's Guatemalan collections, including Staff's syntypes, and he recognized in them two species of the genus *Parafusulina*, *P. sapperi* (Staff) and *P. quatemalensis* Dunbar. On the basis of these fusulinids, Dunbar referred the Paleozoic limestones of Guatemala, from which Sapper's collections were obtained, to the Permian Leonard series.

Meanwhile, Mullerried restudied the various Central American specimens in Mexico City and made additional collections in Chiapas. In 1936 he pointed out for the first time that at least part of the Late Paleozoic strata in Chiapas are Permian in age. This conclusion was based to a considerable extent on this discovery of ammonoids, one of which resembles *Waagenoceras*, which is characteristic of the Permian. In 1941 these ammonoids were described by Miller and Furnish as *Perrinites hilli* (Smith) and *Peritrochia mullerriedi* Miller and Furnish—the first of these species was originally placed in the genus *Waagenoceras*, and it is now known to be quite characteristic of the Leonard horizon in Coahuila, Texas, New Mexico and Oklahoma. These Chiapas ammonoids were found in a boulder of dark gray limestone, believed to have come from the Paseo Hondo formation, on the south trail between Portales and Paseo Hondo. It should also be mentioned that Mullerried lists from the Permian limestones of Chiapas a variety of marine invertebrates, including protozoans, sponges, corals, crinoids, bryozoans, brachiopods (particularly pro-

ductids), pelecypods, gastropods, and ammonoids.

NEW DATA

Our field studies in southeastern Chiapas were conducted largely in three areas (traverses), which are indicated on the accompanying map (fig. 1). One of these extends in a general north-south direction from north of La Vainilla through Palo María to south of Chicomuselo (fig. 3, sec. A). Another is along the bluffs of a northeast-flowing tributary of the Río de Santo Domingo, some 3 to 3.5 miles south (and possibly somewhat east) of Paseo Hondo (fig. 3, sec. B). The third extends in an approximately east-west direction along the north trail between Paseo Hondo and Portales (fig. 3, sec. C).

Paleozoic rocks are widely exposed in the region between La Vainilla and Chicomuselo. The oldest rocks we observed in this area are almost certainly Paleozoic in age, and they outcrop near the village of Chicomuselo. Structurally these beds are near the axis of a large east-west trending anticline (fig. 2). The oldest formation exposed here is more than 1,000 feet thick, and it is composed largely of ferruginous shale, hard abundantly jointed yellowish to brownish-gray partially metamorphosed and altered earthy limestone, and hard sandstone some of which is quartzitic (fig. 3, sec. A). No significant fossils were obtained from this portion of the section. However several of the altered argillaceous limestone beds, which occur stratigraphically 500 feet or more below the top of the formation, contain molds of crinoid columnals, corals, and brachiopods. This thick sequence of clastic rocks probably corresponds to part of the

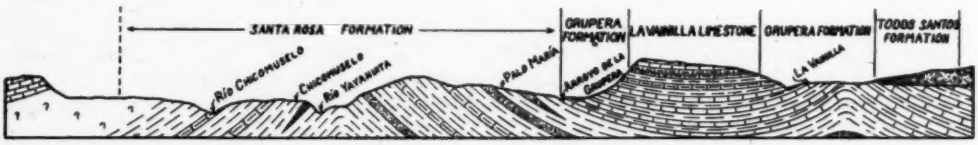


FIG. 2.—Diagrammatic section from north of La Vainilla to south of Chicomuselo, Chiapas.

Santa Rosa beds of Guatemala. Its contact with the overlying fossiliferous strata, near the Arroyo de la Grupera, is not exposed. However, it may well be conformable with them and also be Permian in age.

These Santa Rosa? beds are overlain by more than 350 feet of interbedded shales and limestones which contain many invertebrate fossils. They are well exposed near the Arroyo de la Grupera, and we here propose to call them the Grupera formation. They outcrop east of the trail in the banks of the arroyo, along the trail north of the arroyo, and in the jungle near the trail where small valleys have been developed by erosion. They are exceptionally well exposed along the trail near the foot of the cliff about half a mile north of the stream. Presumably the unexposed intervals in the formation consist of shale. One of the limestones that occurs about 100 feet above the base of the formation contains in abundance two species of fusulinids which we are describing below as *Schwagerina chiapasensis*, n. sp.,

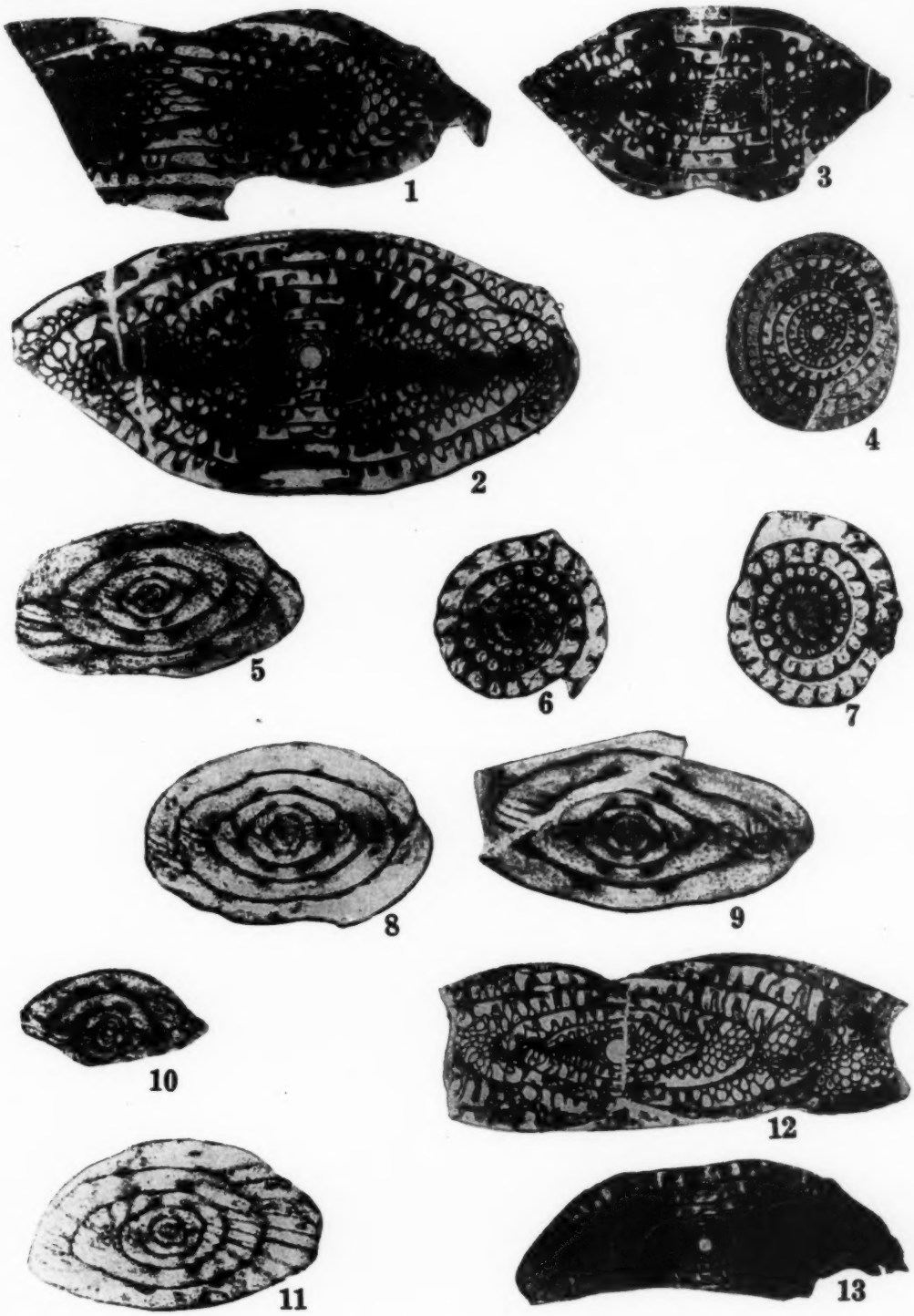
EXPLANATION OF PLATE 79

FIGS. *1–4*—*Schwagerina gruperaensis* Thompson and Miller, n. sp. *1*, Tangential section; *2*, *3*, axial sections; and *4*, sagittal section; all ×10. Grupera formation about 1 mile north of Palo María, Chiapas. (p. 495)

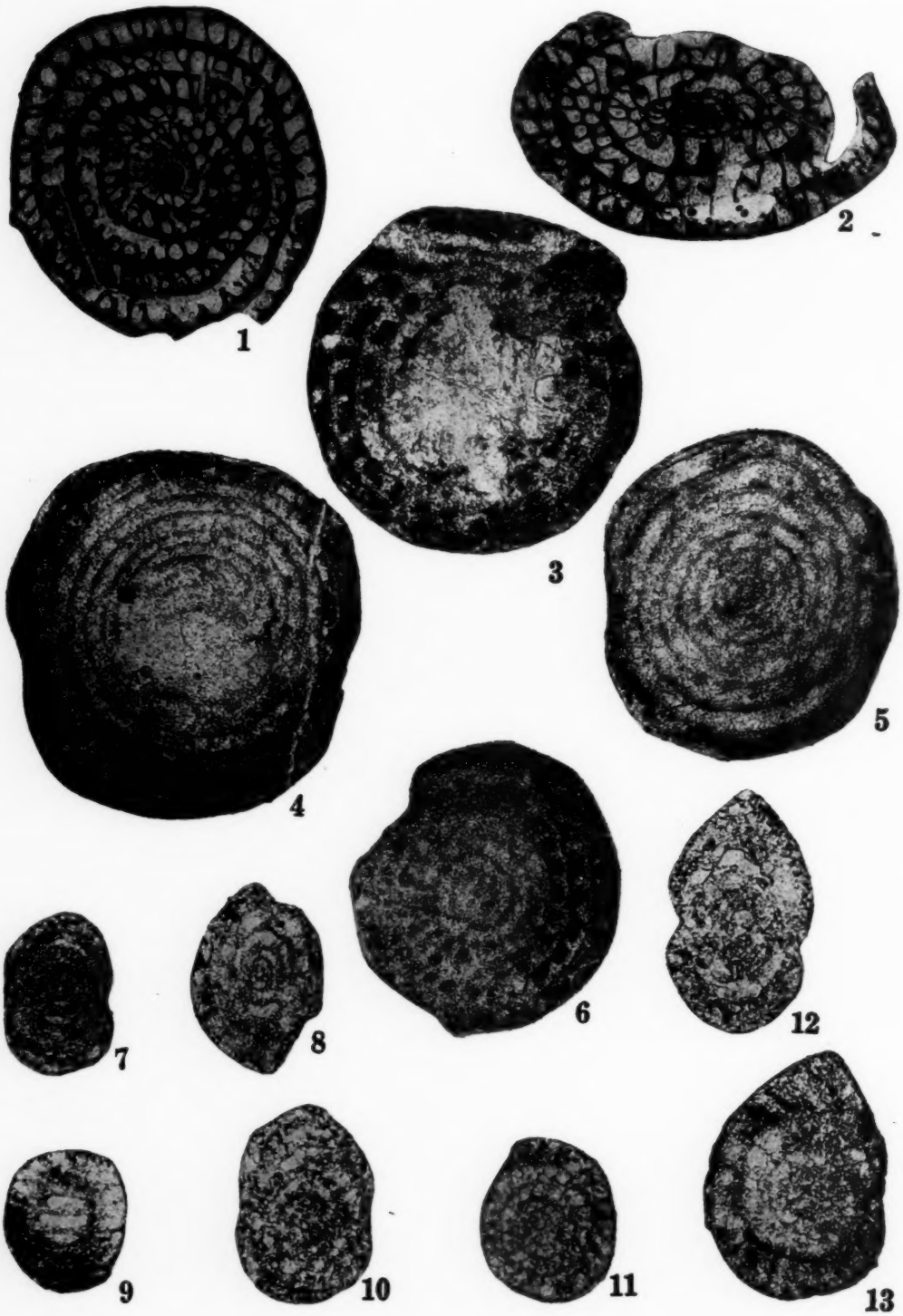
5–11—*Schubertella mullerriedi* Thompson and Miller, n. sp. *5*, *8–11*, Axial sections; and *6*, *7* sagittal sections; all ×20. Paseo Hondo formation about 3½ miles east of Portales. (p. 488)

12—*Schwagerina* sp. A. Slightly oblique axial section, ×10. Paseo Hondo formation about 3½ miles east of Portales, Chiapas. (p. 497)

13—*Schwagerina* sp. C. Axial section, ×10. La Vainilla limestone about 3 miles south of Paseo Hondo, Chiapas. (p. 499)



Thompson and Miller – Permian Fusulines



Thompson and Miller – Permian Fusulines

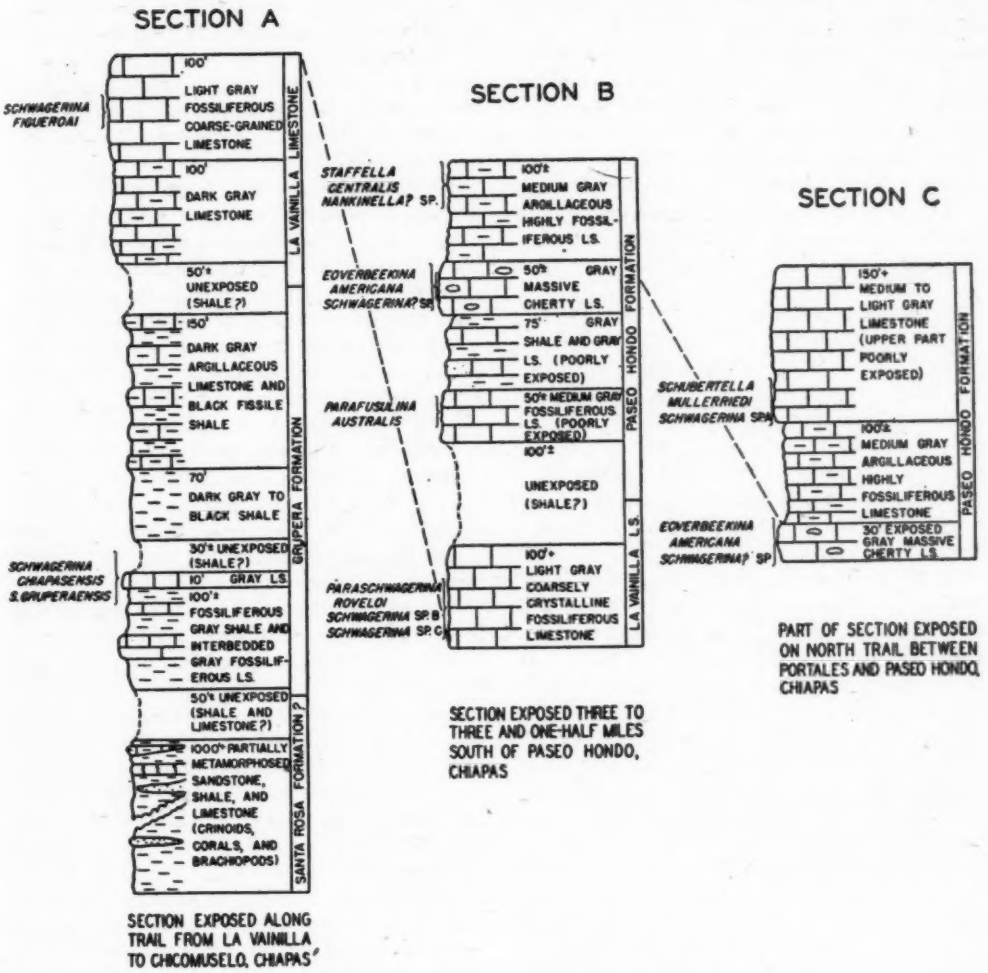

SECTION A
100'
LIGHT GRAY FOSSILIFEROUS COARSE-GRAINED LIMESTONE
SCHWAGERINA FIGUEROAI
100'
DARK GRAY LIMESTONE
LA VAINILLA LIMESTONE
50'± UNEXPOSED (SHALE?)
150'
DARK GRAY ARGILLACEOUS LIMESTONE AND BLACK FISSILE SHALE
70'
DARK GRAY TO BLACK SHALE
GRUPERA FORMATION
30'± UNEXPOSED (SHALE?)
SCHWAGERINA CHIAPASENSIS S. GRUPERAENSIS
10' GRAY LS.
100'± FOSSILIFEROUS GRAY SHALE AND INTERBEDDED GRAY FOSSILIFEROUS LS.
50'± UNEXPOSED (SHALE AND LIMESTONE?)
1000'± PARTIALLY METAMORPHOSED SANDSTONE, SHALE, AND LIMESTONE (CRINOIDS, CORALS, AND BRACHIOPODS)
SANTA ROSA FORMATION?
SECTION EXPOSED ALONG TRAIL FROM LA VAINILLA TO CHICOMUSELO, CHIAPAS
SECTION B
STAFFELLA CENTRALIS NANKINELLA? SP.
100'± MEDIUM GRAY ARGILLACEOUS HIGHLY FOSSILIFEROUS LS.
EOVERBEEKINA AMERICANA SCHWAGERINA? SP.
50'± GRAY MASSIVE CHERTY LS.
75' GRAY SHALE AND GRAY LS. (POORLY EXPOSED)
PASEO HONDO FORMATION
PARAFUSULINA AUSTRALIS
50'± MEDIUM GRAY FOSSILIFEROUS LS. (POORLY EXPOSED)
100'± UNEXPOSED (SHALE?)
LA VAINILLA LS.
PARASCHWAGERINA ROVELOI SCHWAGERINA SP. B SCHWAGERINA SP. C
100'+ LIGHT GRAY COARSELY CRYSTALLINE FOSSILIFEROUS LIMESTONE
SECTION EXPOSED THREE TO THREE AND ONE-HALF MILES SOUTH OF PASEO HONDO, CHIAPAS
SECTION C
150'+ MEDIUM TO LIGHT GRAY LIMESTONE (UPPER PART POORLY EXPOSED)
SCHUBERTELLA MULLERRIEDI SCHWAGERINA SP.
100'± MEDIUM GRAY ARGILLACEOUS HIGHLY FOSSILIFEROUS LIMESTONE
PASEO HONDO FORMATION
EOVERBEEKINA AMERICANA SCHWAGERINA? SP.
30' EXPOSED GRAY MASSIVE CHERTY LS.
PART OF SECTION EXPOSED ON NORTH TRAIL BETWEEN PORTALES AND PASEO HONDO, CHIAPAS

FIG. 3.—Sections of Permian strata in southern Mexico.

EXPLANATION OF PLATE 80

FIGS. *1, 2*—*Paraschwagerina roveloi* Thompson and Miller, n. sp. *1*, Sagittal section; *2*, oblique axial section; both ×10. La Vainilla limestone about 3 miles south of Paseo Hondo. (p. 500)

3–6—*Eoverbeekina americana* Thompson and Miller, n. sp. *3, 6*, Sagittal sections of poorly preserved specimens; *4, 5*, axial sections; all ×20. Paseo Honda formation about 3 miles east of Portales, Chiapas. (p. 492)

7–11—*Staffella centralis* Thompson and Miller, n. sp. *7, 8*, Axial sections; *9*, tangential section showing the unfluted nature of the septa; *10*, oblique section; *11*, sagittal section; all ×30. Paseo Hondo formation about 3½ miles south of Paseo Hondo, Chiapas. (p. 491)

12, 13—*Nankinella?* sp. *12*, Axial section; *13*, sagittal section; both ×30. Paseo Hondo formation about 3½ miles south of Paseo Hondo, Chiapas. (p. 489)

and *S. gruperaensis*, n. sp. These two species are closely similar to forms that have been described from the Hueco limestone of the Franklin Mountains of west Texas, and it is believed that the containing beds are about the same age as the Hueco; that is, that they are referable to the Wolfcamp series of the Lower Permian.

The upper limestones exposed in this section (fig. 3, sec. A) are some 200 feet thick, and they form a prominent limestone bluff north of the Arroyo de la Grupera. They also outcrop near the Hacienda La Vainilla, and we propose to call them the La Vainilla limestone, designating, however, as the type section of the formation the exposure along the trail in the cliff about 1 mile north of Palo María and about three-fourths of a mile south of La Vainilla. The lower half of this formation consists of dark-gray limestone that is essentially unfossiliferous. The upper half of it is composed of coarsely crystalline light gray massively bedded limestone which contains many crinoid columnals, brachiopods, and an abundant fusulinid species described below as *Schwagerina figueroai*, n. sp. This form is an advanced representative of the genus *Schwagerina*, and it seems to indicate that the La Vainilla limestone is younger than the upper part of the type section of the Wolfcamp formation of the Glass Mountains in Texas and older than the base of the *Parafusulina*-bearing Leonard formation of the same area.

The stratigraphic section studied south (and perhaps somewhat east) of Paseo Hondo (fig. 3, sec. B) contains at its base a highly fossiliferous coarsely crystalline light-gray massively bedded limestone that is about 100 feet thick. From this limestone we obtained abundant representatives of *Paraschwagerian roveloi*, n. sp., and scattered specimens described below as *Schwagerina* sp. B. and *S.* sp. C. These fusulinids indicate that the limestone which yielded them is not greatly different in age from the type section of the La Vainilla limestone, with *S. figueroai*, n. sp. Furthermore, the limestone under consideration is lithologically similar to the uppermost limestone in the type section of the La Vainilla near the top of the bluff south of La Vainilla. We are therefore regarding this limestone, which outcrops south of Paseo Hondo, as part of the La Vainilla formation, though we believe that it is slightly younger than the beds exposed in the type section of that formation. Unfortunately, the top of the beds here referred to the La Vainilla is covered and therefore we were not able to determine the relationship between this formation and the overlying strata.

In the sections which we studied, the Permian beds that occur stratigraphically above the La Vainilla limestone total more than 400 feet in thickness, and we here propose to call them the Paseo Hondo formation, after the agrarian colony Paseo Hondo. We have selected as the type section of the formation the exposure some 3 to 3½ miles south, and possibly somewhat east, of Paseo Hondo in the south bluff of a northeast-flowing tributary of the Río de Santo Domingo. All of the Paseo Hondo formation that we studied is exposed here except the uppermost 150 feet, which we observed along the higher passes on the north trail between Portales and Paseo Hondo.

Above the covered interval on top of the La Vainilla limestone some 3 miles south of Paseo Hondo, there is a massive fine-grained limestone that is about 50 feet thick. This limestone contains in considerable abundance *Parafusulina australis*, n. sp., a primitive representative of the genus, indicating that the containing beds are of about the same age as the lower *Parafusulina* zone of the Leonard formation of west Texas.

Above this lower limestone member of the Paseo Hondo formation at this locality, there is an interval of about 75 feet in which limestones and shales are poorly exposed. Next comes about 50 feet of cherty gray massive limestone, which we are placing in the Paseo Hondo and which fairly teems with the tests of *Eoverbeekina americana*, n. sp., and scattered specimens of *Schwagerina?* sp. This member may well be called an *Eoverbeekina*-limestone, for it is largely composed of tests belonging in that genus.

The uppermost limestone that we studied at the type section of the Paseo Hondo formation is about 100 feet thick. It is composed of very argillaceous dark-gray massively bedded highly fossiliferous limestone which contains abundant gastropods and brachiopods, innumerable specimens of *Staffella centralis*, n. sp., a good many representatives of *Nankinella?* sp., and scattered individuals that are being referred with

question to the genus *Schwagerina*. None of these fusulinids can be said to fix the age of the limestone in which we found them, but collectively they indicate that this member of the Paseo Hondo is probably also equivalent to the lower Leonard.

The section exposed near the high passes along the north trail between Portales and Paseo Hondo consists of three quite distinct and easily recognizable lithologic members of the Paseo Hondo formation (fig. 3, sec. C). Only 30 feet of the lower of these units is exposed at this place. These 30 feet consist of gray cherty massively bedded limestone containing *Eoverbeekina americana*, n. sp., in extreme abundance and scattered specimens of *Schwagerina?* sp. Lithologically these beds are essentially identical with the *Eoverbeekina*-bearing limestone of the type section of the Paseo Hondo formation, and they are almost certainly of the same age.

The second unit of the Paseo Hondo formation exposed along this trail is about 100 feet thick, and it is composed of medium-gray highly argillaceous massively bedded fossiliferous limestone which contains a large fauna of gastropods and brachiopods that seem to be identical with many of those found in the uppermost unit of the section studied south of Paseo Hondo. However, we failed to secure a rock collection from this limestone along the north Portales-Paseo Hondo trail, and hence we are unable to ascertain whether or not it contains such minute forms as *Staffella centralis*, n. sp., and *Nankinella?* sp., which occur in what we believe to be the same limestone south of Paseo Hondo.

The uppermost limestone exposed in the bluff along the north trail between Portales and Paseo Hondo is about 150 feet thick. It is a gray massive limestone that contains, in at least its lower portions, numerous tests of *Schubertella mullerriedi*, n. sp., and scattered specimens described below as *Schwagerina* sp. A. This uppermost limestone member of the Paseo Hondo formation is truly a *Schubertella*-limestone, for it is composed largely of the shells of *Schubertella mullerriedi*. That species is closely similar to *S. melonica* Dunbar and Skinner of the upper portion of the Leonard formation of west Texas, suggesting that the containing beds are of about the same age in these two widely separated localities. It now seems almost certain that the ammonoids described by Miller and Furnish in 1941 as *Perrinites hilli* (Smith) and *Peritrochia mullerriedi* M. and F. came from this uppermost member of the Paseo Hondo formation along the south trail between Portales and Paseo Hondo, and they also are of Leonard age.

STRATIGRAPHIC SUMMARY

The Paleozoic strata of southeastern Chiapas are more than 2000 feet thick, and they are composed of several different types of sedimentary rocks. Those that we studied most consist largely of limestones and shales, but sandstones and conglomerates are not rare in the lower part of the sequence. It seems logical to divide these sedimentary rocks into four stratigraphic units or formations. The lowermost, which is more than 1000 feet thick, can be tentatively referred to the Santa Rosa formation of Dolfuss and de Mont-Serrat; the second, about 400 feet thick, we are calling the Grupera formation; the third, some 300 feet of limestone, is being designated the La Vainilla limestone; and we are suggesting the formational name Paseo Hondo for the uppermost, which consists of some 475 feet of limestone with some shale.

Although no significant fossils have been found in the beds that we are doubtfully placing in the Santa Rosa formation, we are inclined to believe that they are Lower Permian in age. Limestones in the Grupera formation have yielded a considerable fauna, including fusulinids that indicate an equivalency to part of the Hueco formation (Wolfcamp series) of the Franklin Mountains in west Texas. The La Vainilla limestone contains fusulinids which seem to be younger than those of the Wolfcamp formation of the Glass Mountains in west Texas and older than those of the *Parafusulina* zone of the Leonard in the same general area. Both the fusulinids and the ammonoids of the Paseo Hondo formation clearly indicate a correlation with the Leonard.

DISPOSITION OF SPECIMENS

All figured specimens have been deposited in the paleontological collection of the State University of Iowa. The remainder of the type material has been divided among

the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

All illustrations on the accompanying plates are unretouched photographs.

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE Möller
Subfamily SCHUBERTELLINAE Skinner
Genus SCHUBERTELLA Staff and Wedekind

The genus *Schubertella* was established by Staff and Wedekind in 1910, and its genotype is *S. transitoria* Staff and Wedekind of the lower Permian of Spitzbergen (Svalbard). The original description of this genotype is generalized and the accompanying illustrations are drawings that do not give precise information as to the internal structure of the test. However, in 1937, Thompson published a detailed description and photographic illustrations of topotype material. He showed that the spirotheca is composed of a tectum and a lower relatively thick layer, that the juvenarium is distinctly endothyroid and asymmetrical, and that prominent chomata border the tunnel throughout the fusiform portion of the shell. Forms that are similar enough to this genotype to be regarded as congeneric with it and therefore to belong in the genus *Schubertella* have been found in Permian strata ranging in age from lower Wolfcamp to at least well up into the *Yabeina* zone of the upper Permian. Also, several undescribed species are known from the Pennsylvanian that are probably referable to this genus.

One of our collections from Chiapas contains specimens of a limestone that is largely composed of tests of a new species of *Schubertella* which we are terming *S. mullerriedi*. This form is closely similar to *S. melonica* Dunbar and Skinner of the upper Leonard of Texas. It should be pointed out that the spirotheca of these two forms is much thinner than that of the genotype of *Schubertella*. In both *S. müllerriedi* and *S. melonica* the spirotheca is composed of only one layer throughout most of the shell of mature specimens, and it is possible that these forms may represent a distinct genus of the subfamily Schubertellinae.

Representatives of the genus *Schubertella* are widely distributed geographically, and they have a long stratigraphic range. Therefore, the mere presence of a species of the genus in Chiapas does not give much of a clue as to the precise age of the containing strata. However, the very close similarity of *S. müllerriedi* to *S. melonica* suggests that the Chiapas limestone in which it occurs is not greatly different in age from that portion of the Leonard formation of Texas in which *S. melonica* is found.

SCHUBERTELLA MÜLLERRIEDI
Thompson and Miller n. sp.
Plate 79, figures 5–11

Shell minute, ellipsoidal to inflated fusiform, with broadly convex lateral slopes and essentially straight axis of coiling in outer four volutions. Mature specimens consist of six volutions, measure about 0.9 mm. in width, 1.8 mm. in length. Average form ratios of first to sixth volutions for three typical specimens 1:0.8, 1:1.1, 1:1.6, 1:2.1, 1:2.2, and 1:2.0, respectively. In some specimens second volution has form ratio of more than 1:1.

Proloculum minute, in five specimens outside diameter measures 45 to 67 microns, averages 54 microns. Inner one to two volutions distinctly endothyroid and tightly coiled. In some specimens axis of coiling of inner volutions inclined as much as 90 degrees to axis of coiling of outer volutions. Outer four to five volutions of mature specimens of six volutions distinctly planispiral. Heights of first to sixth volutions of six typical specimens 14 to 33, 29 to 43, 36 to 51, 58 to 76, 80 to 112, and 96 to 144 microns, respectively, averaging 23, 36, 48, 67, 101, and 129 microns, respectively.

Septa thin, numerous, essentially normal to lower surface of spirotheca. Septal counts of first to sixth volutions of four typical specimens 7 to 9, 15, 15, 17 to 18, 18 to 20, and 19 to 22, respectively, averaging 8, 15, 15, 18, 19, and 21, respectively. No indication of septal fluting observed in any of several dozen thin sections of syntypes of this species.

Spirotheca thin, composed of tectum and very thin lower layer observed only in middle part of shell of outer volutions of mature specimens. Spirotheca of inner volutions in most specimens appears to be composed of only one layer, measures 15 to 20 microns in fifth and sixth volutions.

Tunnel low, broad. Chomata well developed throughout all except inner one or two volutions, relatively narrow, essentially symmetrical in cross section. However, tunnel sides of chomata slightly steeper than poleward sides in most portions of shell. Highest chomata found in next to last volution of mature specimens, approximately one-half as high as chambers. Tunnel angles of third to sixth volutions of five typical specimens measure 20 to 25, 25 to 36, 32 to 48, and 45 to 70 degrees, respectively, averaging 22, 30, 38, and 53 degrees, respectively.

Remarks.—The spirotheca of this species is as thin or thinner than that in other congeneric forms, and this fact seems to suggest a degenerate or a primitive stage. All of the other internal features of the test are closely similar to those of the genotype, *S. transitoria* Staff and Wedekind.

S. müllerriedi resembles *S. melonica* Dunbar and Skinner of the upper Leonard of Texas more closely than any other known species, and these two forms are undoubtedly very closely related. However, our species appears to be larger at maturity, to have a smaller form ratio at maturity, and to have a smaller proloculum than *S. melonica*. The type specimens of these two species resemble each other so closely that it seems possible that they may represent varieties of the same species. *S. müllerriedi* also resembles somewhat *S. kingi* Dunbar and Skinner of the Wolfcamp of Texas. However, that species has a smaller form ratio for corresponding volutions, is smaller and has a smaller number of volutions at maturity, has an endothyroid juvenarium of more volutions, and has a different general shell shape than the form under consideration.

Occurrence.—*S. müllerriedi* is extremely abundant in a massive limestone, which can be termed a *Schubertella*-limestone, in the Paseo Hondo formation of Chiapas. It is exposed well up in the bluff on the south side of the north trail between Portales and Paseo Hondo about 3½ miles east of Portales and just west of the eastern of the two passes between Portales and Paseo Hondo (fig. 3, sec. C). The elevation of the trail at this point is about 850 meters. *S. müllerriedi* occurs here in association with scattered specimens of a form described below as *Schwagerina* sp. A.

Repository.—State Univ. Iowa, 3130 (figured specimens). Remainder of type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Subfamily OZAWAINELLINAE Thompson and Foster

Genus NANKINELLA Lee

The genus *Nankinella* was proposed by Lee in 1933, and *Staffella discoides* Lee was designated as its genotype. The original illustrations (photographs) of *N. discoides* show that the syntypes of the genotype of *Nankinella* are poorly preserved, and Lee's section are not well oriented. We are therefore not certain that we have a true concept of the type species of *Nankinella*. However, it is clear that the early volutions of the genotype are discoidal and that they have a sharply angular periphery. The outer volution seems to be broadly discoidal with a broadly angular to narrowly rounded periphery. As has been pointed out by Lee, *Nankinella* has a spirotheca composed of a tectum and a diaphanotheca, with upper and lower surface layers. The type species of the genus *Ozawainella* Thompson[1] has a sharply angular periphery throughout the shell, and the spirotheca of that form is very thin and primitive in nature.

NANKINELLA? sp
Plate 80, figures 12, 13

One of our collections from the upper part of the Paseo Hondo limestone contains

[1] It now seems almost certain that two species are represented by the specimens which Colani figured in 1924 as the syntypes of *Fusulinella angulata* Colani, the genotype of *Ozawainella*. One of these species is illustrated by an axial section which shows a highly discoidal fusulinid with thin spirotheca and a sharply angular periphery throughout the shell. This is the type of form described by Thompson in 1935 for the genotype of *Ozawainella*. The other species is represented by a sagittal section of a form with a thick spirotheca composed of a tectum and a keriotheca, and with very highly fluted septa. These two specimens represent different species belonging in different genera. We are selecting as the holotype of *Ozawainella angulata* (Colani) the specimen represented by figure 20 on Colani's plate 2 of 1924.

abundant specimens of a small subdiscoidal fusulinid that may be referable to the genus *Nankinella* Lee. Unfortunately, the preservation of all our specimens is exceedingly poor and we are unable to determine many of the significant characters of this form. However, largely for the sake of completeness we are illustrating axial and sagittal sections, and we have drawn up the following brief description, which is based on thin sections of more than a dozen specimens.

Shell minute, discoidal, with narrowly rounded to broadly angular periphery and depressed polar regions (umbilicate). Largest specimen contains five volutions, measures about 1.2 mm. in width, 0.7 mm. in length. Form ratio of largest specimen about 1:0.6. Because of poor preservation of available material, we can not determine nature of spirotheca, septal structures, or chomata. Last volution of a specimen of five volutions contains 22 septa. Nature of tunnel not ascertained.

Remarks.—We have been able to determine so little about this form that detailed comparisons with previously described species are difficult. In general development the form under consideration resembles *Ozawainella huecoensis* Dunbar and Skinner of the Hueco limestone of Texas. However, our Central American specimens are much smaller, have fewer volutions, and are umbilicate. Furthermore, it seems quite probable that other marked differences between these two forms would be apparent from better preserved material.

Occurrence.—This form is very abundant in a dark-gray highly fossiliferous argillaceous limestone member of the Paseo Hondo formation which outcrops at the top of the first hill south of the northeast-flowing tributary of the Río de Santo Domingo about 3½ miles south (and possibly somewhat east) of Paseo Hondo, Chiapas. It occurs there in association with many gastropods, brachiopods, and bryozoans, scattered specimens of *Schwagerina?* sp., and an abundance of *Staffella centralis*, n. sp.

Repository.—State Univ. Iowa, 3131 (figured specimens). Remainder of material studied is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Subfamily FUSULININAE Rhumbler?
Genus STAFFELLA Ozawa

The genus *Staffella* was established by Ozawa in 1925 and "*Staffella sphaerica* v. Möller" [= *Fusulinella sphaerica* Möller] of the Permian of Armenia was designated as the genotype. In 1935 Thompson proposed to make Möller's specimens the types of the species *Staffella moellerana* for he did not believe that they were conspecific with the specimens from the Permian of Armenia for which Abich had originally proposed the name *Fusulina sphaerica*. Accordingly, the genotype of *Staffella* is here referred to as *S. moellerana*.

Möller's illustrations of *S. moellerana* (drawings published in 1878) do not give many of the details of the internal features of the species, and his description is generalized. However, in 1939 Licharew *et al.* illustrated and described from the Permian strata of Armenia specimens that seem to be conspecific with those studied by Möller. These newer illustrations and description add considerable information to our knowledge of the genus *Staffella*, though unfortunately Licharew's specimens, like Möller's, are poorly preserved. A translation from the Russian of Licharew's description and discussion of topotype specimens of *Staffella moellerana* (called *Staffella sphaerica* Abich by Licharew) follows:

> Shell large, in the adult stage approaching spool-shape, rather highly compressed with reference to the axis of coiling, in axial section it is oval; on each side are flat umbilici; the primary whorls are nautiloid or lens-shaped; the coiling is very even; there are many whorls; E. K. [proloculum] small, oval or spherical; the septa are flat; the aperture is in the shape of a somewhat narrow slit; along the sides of the tunnel are rather massive chomata which fade out in the last whorl.
>
> From *Pisolina abichi* Dout., sp. nov., with which it is commonly found and to which it is outwardly akin, *Staffella sphaerica* differs (aside from generic features) in the appearance of nautiloid lenticular primary whorls and in the smallness of its dimensions.
>
> Lower Permian. Transcaucasus section of dark limestone in the Arax Valley. Outside of the U. S. S. R., it possibly is present in strata of Tsis of south China and in the Permian sediments of northern Iran.

Until recently, most spherical to subspherical Pennsylvanian and Permian fusulinids that contain a tunnel and chomata

have been referred to *Staffella*. However, in 1942 Thompson emended that genus and proposed *Pseudostaffella* (with *P. needhami* Thompson as genotype) for most of the lower Pennsylvanian subspherical fusulinids generally referred to *Staffella*. As noted in our discussion of the genus *Eoverbeekina* below, Licharew's illustrated axial section of *S. moellerana* resembles very closely our illustrated holotype of *E. americana*, and further studies may show that *Eoverbeekina* is synonymous with *Staffella*. The resemblance of these two genera was pointed out by Lee in 1933 when he proposed *Eoverbeekina*. It is therefore possible that the form we are describing as *Staffella centralis*, n. sp., is not congeneric with the genotype of *Staffella*. Furthermore, it is obviously not congeneric with the genotype of *Eoverbeekina* for it has a well-developed tunnel throughout the shell and it does not contain foramina.

STAFFELLA CENTRALIS
Thompson and Miller, n. sp.
Plate 80, figures 7–11

Shell minute, planispiral throughout ontogenetic development, subspherical in shape, with broadly rounded periphery and slightly depressed polar regions (umbilicate). Mature specimens contain four to five and one-half volutions, measure 0.6 to 0.7 mm. in length, 0.8 to 1.1 mm. in width. Inner two volutions compressed sublenticular with narrowly rounded to broadly angular periphery and form ratio of about 1:0.5. After development of second volution, periphery becomes broadly rounded and form ratio of mature specimens is about 1:0.75. Averages of form ratios of first to fifth volutions of two typical specimens 1:0.49, 1:0.58, 1:0.69, 1:0.75, and 1:0.74, respectively.

Proloculum minute, outside diameter about 45 microns. Rate of expansion of shell essentially uniform, heights of first to fifth volutions of typical specimen about 30, 50, 80, 133, and 166 microns, respectively.

Septa numerous, essentially normal to lower surface of spirotheca. Septal counts of second to fifth volutions of a typical specimen 8, 13, 19, and 21, respectively. Septa unfluted throughout length of shell, as shown by tangential section illustrated by figure 11 on plate 80.

Spirotheca thin, insofar as can be determined, composed of tectum and thicker much less dense lower layer (diaphanotheca). Shells largely replaced by secondary calcite during fossilization, exact nature of finer details of internal features not determined with certainty.

Tunnel low, relatively broad. Suggestion of chomata bordering tunnel throughout shell, but most specimens so poorly preserved that we cannot determine with certainty exact nature of chomata.

Remarks.—Representatives of this species are extremely abundant in one of our collections from southernmost Mexico. We have prepared thin sections of several hundred specimens, but none of them is well preserved. All of the general features are, to be sure, readily ascertainable, but the finer details cannot be seen clearly. Much information in addition to that given above could undoubtedly be obtained from well-preserved specimens.

Staffella centralis resembles in general shape and internal structures the type species of the genus, *S. moellerana* Thompson. However, the latter species is much larger and has a greater number of volutions at maturity, and there are more septa in the outer volutions of mature specimens. Peculiarly enough, this Central American species is associated with a form that may be referable to the genus *Nankinella* Lee, just as *S. moellerana* is associated with a questionable species of *Nankinella*, *N.? caucasica* Doutkevitch. However, we do not believe that this fact necessarily indicates that *S. moellerana* and *S. centralis* are contemporaneous. It should also be mentioned that *S. centralis* is smaller, is more tightly coiled, and has better developed chomata than *S. lacunosa* Dunbar and Skinner of the Leonard of Texas.

Occurrence.—*S. centralis* is extremely abundant in a dark-gray argillaceous limestone that is exposed along the trail at the divide on the southeast side of a northeast-flowing tributary of the Río de Santo Domingo about 3½ miles south (and possibly somewhat east) of Paseo Hondo, Chiapas. This limestone is the uppermost member of the type section of the Paseo Hondo formation (but not the uppermost member of the formation). *S. centralis* occurs in association

with abundant specimens of *Nankinella?* sp. and *Schwagerina?* sp.

Repository.—State Univ. Iowa, 3132 (figured specimens). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Subfamily VERBEEKININAE Staff and Wedekind

Genus EOVERBEEKINA Lee

The genus *Eoverbeekina* was established by Lee in 1933 and *E. intermedia* Lee of the Chihsia limestone of southern China was designated as the genotype. In 1937 Thompson and Foster described *E. cheni* from the Yanghsin limestone of western China. Insofar as we have been able to ascertain, these are the only previously described representatives of the genus.

Two of our collections from southern Chiapas near the Guatemalan border contain an abundance of specimens of an undescribed species of *Eoverbeekina* that we are terming *E. americana*. Some of our specimens are well preserved and show clearly the internal features of the test. These individuals give us considerable new information about the genus.

From all of the available material, that is, from the published illustrations and description of the genotype and specimens of the known congeneric forms, we have drawn up the following generic diagnosis of *Eoverbeekina*.

Shell small, spherical to subspherical with broadly rounded periphery, slightly depressed axial regions (umbilicate), straight axis of coiling, and form ratio closely approximating or slightly greater than unit value. Mature specimens consist of 9 to 15 volutions, measure 2.7 to 4.0 mm. in diameter. Juvenarium subspherical, with narrowly rounded to angular periphery. Periphery of mature specimens broadly rounded.

Proloculum small, essentially spherical. Shell expands uniformly up to seventh or eighth volution, beyond seventh volution chambers of approximately uniform height, or become somewhat more tightly coiled in outer three to four volutions.

Spirotheca thin, composed of thin tectum, and thicker lower layer that probably corresponds to diaphanotheca or keriotheca of other fusulinids. Lower surface of spirotheca covered by layer of dense calcite.

A single tunnel occurs in inner four to five volutions of test. In following volution it is divided into two tunnels or foramina. Beyond fourth volution, numerous foramina appear, tunnel not recognizable as such. In inner four to five volutions tunnel bordered by well-developed chomata. In outer volutions parachomata poorly developed between foramina.

General shape of shell and internal structure of outer volutions of representatives of *Verbeekina* Staff and *Eoverbeekina* are closely similar. However, representatives of *Eoverbeekina* may be distinguished by presence of a lenticular juvenarium, a tunnel in the early volutions, and well-developed chomata bordering the tunnel.

The stratigraphic range of *Eoverbeekina* is not well known, for only three species of the genus (including the Chiapas form described below) have so far been found. In China the genus occurs in rocks that are generally considered approximately equivalent in age to the Leonard or Word formations of America. *Eoverbeekina* is believed to be ancestral to *Verbeekina* and the stratigraphic occurrence of representatives of these genera do not contradict this conclusion. That is, *Verbeekina* occurs in rocks of Guadalupian age in Sicily and Afghanistan, and in rocks probably of Guadalupian age in southern and western China, Sumatra, Japan, and French Indo-China.

EOVERBEEKINA AMERICANA Thompson and Miller, n. sp.

Plate 80, figures 3–6;
plate 83, figures 3–7

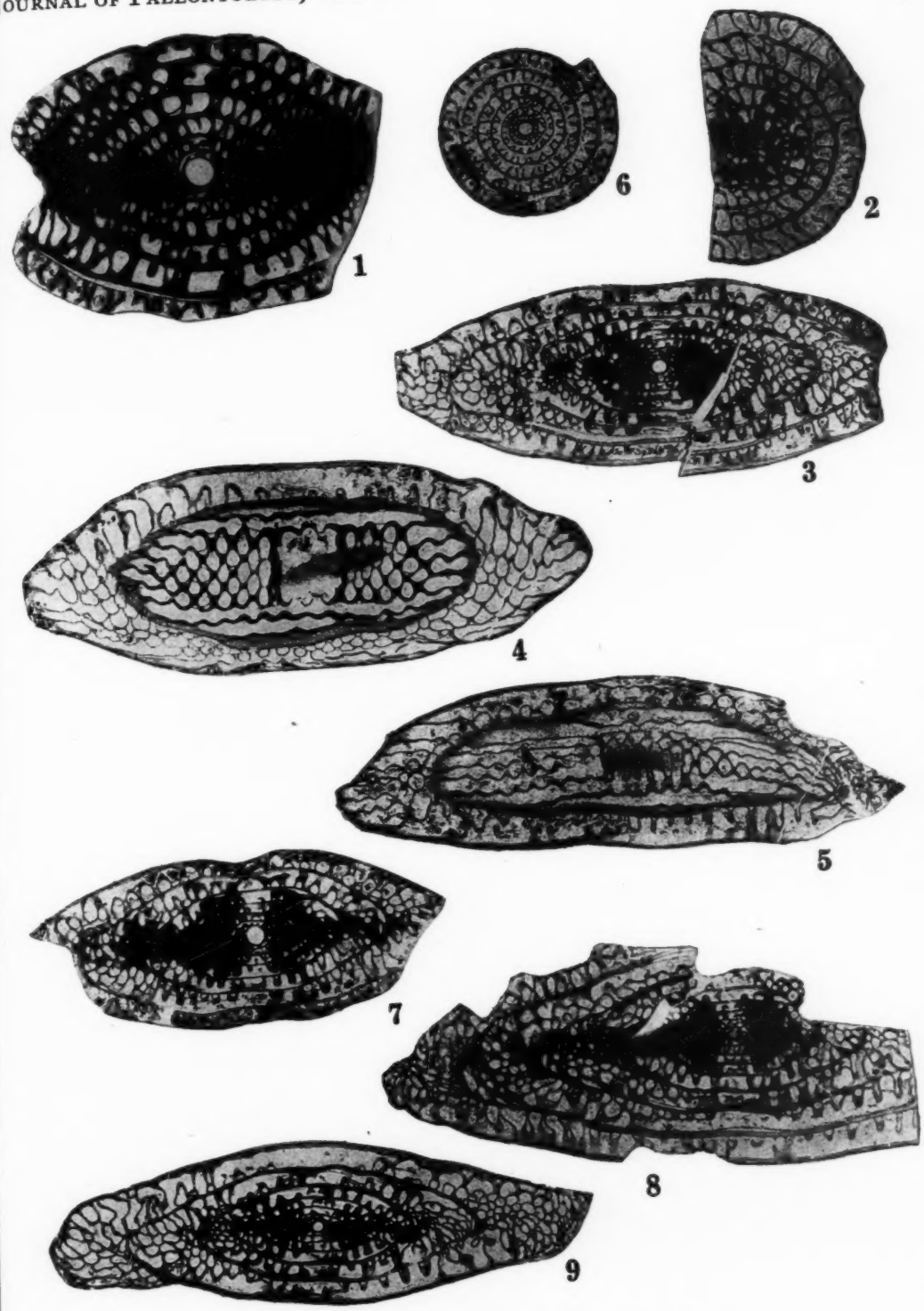
Shell small, spherical to subspherical with depressed to slightly elevated polar

---

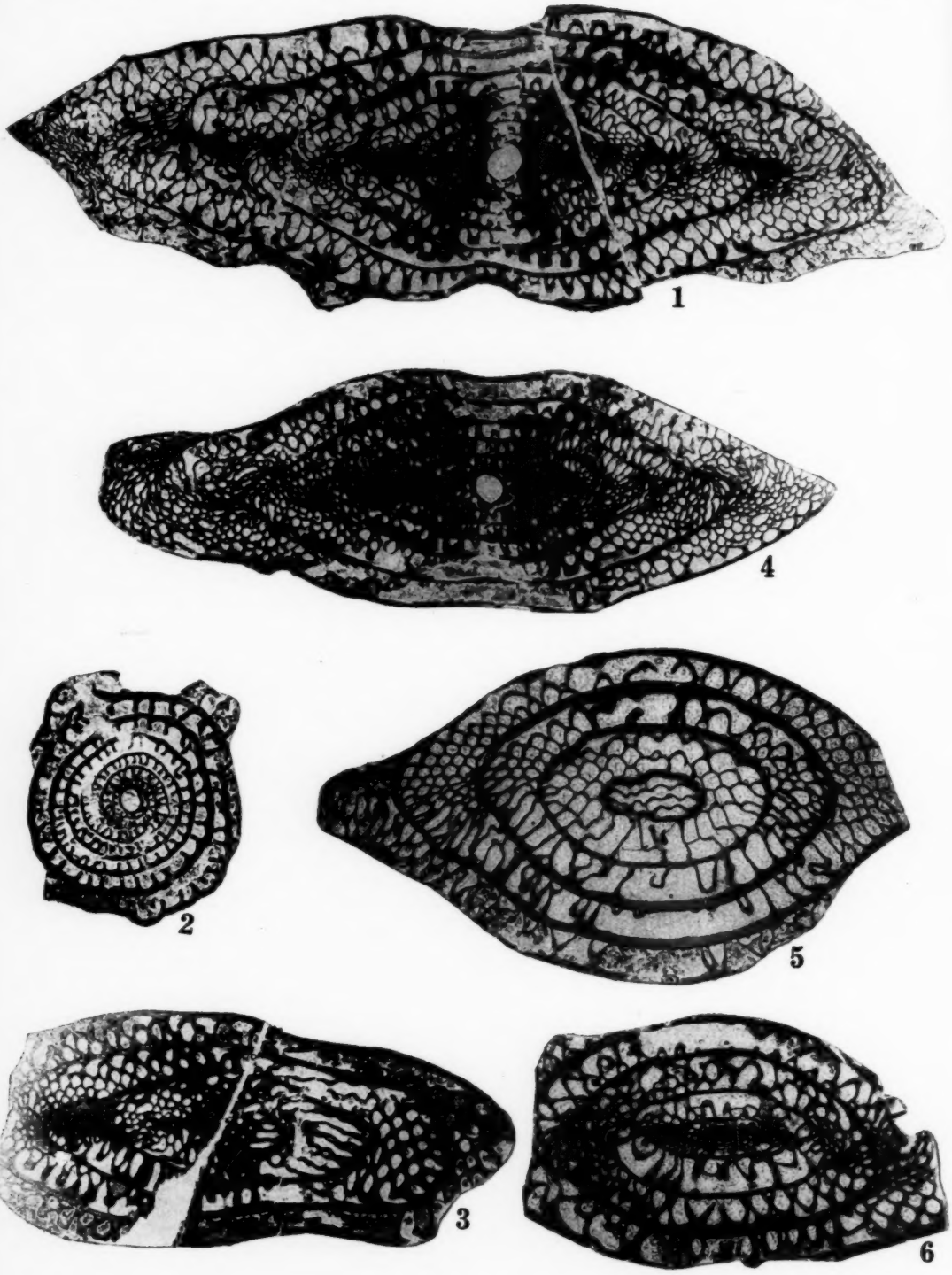
EXPLANATION OF PLATE 81

FIGS. *1*—*Schwagerina* sp. B. Axial section, ×10. La Vainilla limestone about 3 miles south of Paseo Hondo, Chiapas. (p. 498)

2–9—*Parafusulina australis* Thompson and Miller, n. sp. *2*, Parallel section; *3*, *7–9*, axial sections; *4*, *5*, tangential sections that show the poorly developed cuneculi; *6*, sagittal section; all ×10. Paseo Hondo formation about 3½ miles south of Paseo Hondo, Chiapas. (p. 503)



Thompson and Miller – Permian Fusulines



Thompson and Miller – Permian Fusulines

regions and straight axis of coiling, Mature specimens consist of 13 to 15 volutions, eight mature specimens measure 2.6 to 3.1 mm. in length, 3.0 to 3.5 mm. in width. Form ratios of eight mature specimens vary from 1:0.89 to 1:0.76. Form ratios of first to twelfth volutions of a typical specimen 1:0.75, 1:0.78, 1:0.80, 1:0.83, 1:0.96, 1:1.06 1:1.04, 1:0.97, 1:0.92, 1:0.85, 1:0.83, and 1:0.77, respectively. Juvenarium has narrowly rounded to bluntly angular periphery, but periphery gradually becomes broadly rounded in outer volutions of mature specimens.

Proloculum minute, essentially spherical. Outside diameters of prolocula of three specimens average about 60 microns. Expansion of shell uniform in inner volutions but outer volutions of mature specimens become more tightly coiled. Heights of first to twelfth volutions of a typical specimen 33, 67, 83, 116, 133, 150, 183, 183, 167, 167, 150, and 150 microns, respectively.

Spirotheca composed of thin tectum and thicker layer containing fine structures that may correspond to alveoli of other fusulinids. Lower surface of spirotheca partially covered by thin layer of dense calcite. Thicknesses of spirotheca in middle of periphery of third to twelfth volutions of typical specimen 17, 24, 29, 32, 32, 36, 37, 38, 42, and 43 microns, respectively.

Septa numerous, their thickness corresponds very closely to thickness of overlying spirotheca, of essentially uniform thickness throughout their height. Septa slope somewhat anteriorly to spirotheca of preceding volution, acute angle between septa and spirotheca of following chamber about 75 degrees. Three specimens have average septal counts of 20 for twelfth volution, 24 for thirteenth volution, 25 for fourteenth volution. Septa unfluted throughout length of shell.

Tunnel low, narrow in inner four volutions, fifth volution divided into two parts, beyond sixth volution numerous foramina develop. Principal tunnel not identifiable in outer portion of shell beyond sixth or seventh volution. Asymmetrical chomata one-third to one-half height of chambers border tunnel in inner five volutions; chomata present on outer sides of double tunnels in fifth and sixth volutions. Parachomata poorly developed between foramina in outer volutions of mature specimens, but extend only short distance across chambers. In typical specimen 2, 2, 16, and 18 foramina occur in fifth, sixth, seventh, and eight volutions, respectively.

Remarks.—This species is the first representative of the genus *Eoverbeekina* or of the subfamily Verbeekininae to be recognized from America. Only two species of *Eoverbeekina* have been described previously, and both of them are from China. *E. americana* is so markedly different from both of the Chinese species, *E. intermedia* Lee and *E. cheni* Thompson and Foster, that specific comparisons are unnecessary.

Occurrence.—*E. americana* is extremely abundant throughout at least 50 feet of a medium-gray to bluish-gray, massive to massively bedded limestone member of the Paseo Hondo formation of Chiapas. In the areas where this limestone was studied, it is cut by numerous small faults and calcite veins, and it contains scattered, finely divided masses of chert. Most of the specimens we have seen of this species are at least partially replaced by silica or secondary calcite and many of the detailed internal structures can not be determined from them. The weathered surfaces of the limestone are essentially covered with the small spherical silicified shells of this species. It should be mentioned that specimens of *E. cheni?* and *E. intermedia* are exceedingly abundant in the Chihsia limestone of southern China and the shells weather out on the limestone with about the same type of preservation as with the Chiapas species (Lee, 1931, p. 282; 1933, pp. 18, 19, 24). The finer details of the internal structures of the Chinese specimens were also largely destroyed during fossilization.

EXPLANATION OF PLATE 82

FIGS. *1–4—Schwagerina figueroai* Thompson and Miller, n. sp. *1, 4*, Axial sections; *2*, sagittal section; *3*, tangential section; all ×10. La Vainilla limestone about ¾ mile south of La Vainilla, Chiapas. (p. 496)

5, 6—Paraschwagerina roveloi Thompson and Miller, n. sp. *5*, Tangential section; *6*, axial section; both ×10. La Vainilla limestone about 3 miles south of Paseo Hondo, Chiapas. (p. 500)

Large collections of *E. americana* were obtained from the Paseo Hondo formation at two localities in southern Chiapas. One of these is along the southeast bluff of a northeast flowing tributary of the Río de Santo Domingo about 3½ miles south (and possibly somewhat east) of Paseo Hondo. The other collection was obtained along the north trail between Portales and Paseo Hondo at the first pass, that is, about 3 miles, east of Portales. This species occurs in association with scattered small specimens that seem to be juvenile representatives of *Schwagerina*.

Repository.—State Univ. Iowa, 3133 (figured specimens from 3 miles east of Portales) and 3134 (figured specimen from 3½ miles south of Paseo Hondo). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Subfamily SCHWAGERININAE Dunbar and Henbest
Genus SCHWAGERINA Möller

In 1877 Möller established the genus *Schwagerina* and designated *Borealis princeps* Ehrenberg as a typical species, but he did not describe or illustrate any species at that time. However, the following year, he illustrated and described as *S. princeps* specimens that are entirely different from the syntypes of that species, and for more than fifty years the name *Schwagerina* was applied to fusulinids similar to the species described by Möller in 1878 and not closely related to Ehrenberg's type specimens. In 1936 Dunbar and Skinner restudied the type specimens of *Borealis princeps* and redefined *Schwagerina* accordingly. They proposed the name *Pseudoschwagerina* for part of the forms that had previously been referred to *Schwagerina*, and the name *Paraschwagerina* for most of the remainder.

Clearly Ehrenberg's specimens are poorly preserved, and it is not possible to determine with certainty the exact nature of all of the internal features of the genotype of *Schwagerina*. However, as pointed out by Dunbar and Skinner, it has fluted septa throughout its length, a gradually expanding shell, and a spirotheca composed of a tectum and a keriotheca. The nature of the axial fillings, if any exist, can not be determined with certainty, for they would most probably have been replaced during fossilization. It should be noted in this connection, that many species which we believe are correctly referred to the genus *Triticites* Girty also have septa that are fluted throughout the length of the shell.

In this report, we are interpreting the genus *Schwagerina* rather broadly, and are allowing it so much latitude that stratigraphically it ranges throughout all the fusulinid-bearing portions of the Permian. However, several of the species we are describing are closely similar to forms found in the upper part of the lower Permian Hueco limestone of the Franklin Mountains of Texas, and presumably, therefore, the containing beds in Chiapas are lower Permian in age. Other Chiapas forms that we are referring to *Schwagerina* come from beds that we believe to be of Leonard age.

It is quite possible that most of the Chiapas species we are referring to *Schwagerina* should be placed in *Leeina* Galloway, of which the genotype is *Fusulina vulgaris fusiformis* Schellwien. Nevertheless, for the present, at least, we believe it will be best to include them in *Schwagerina*.

SCHWAGERINA CHIAPASENSIS Thompson and Miller, n. sp.

Plate 83, figures 1, 2; plate 84, figures 1–3

Shell large, fusiform. Inner four to five volutions have sharply pointed poles, convex lateral slopes. Outer one to two volutions have bluntly rounded poles, concave lateral slopes. Polar extremities of sixth volution become highly extended. Mature specimens consist of six volutions, measure 15 to 20 mm. in length, 6.8 mm. in width, giving form ratio of 1:2.1 to 1:2.6. However, form ratio of sixth volution of some specimens is slightly less than 1:3.0. Form ratios of first to fifth volutions of a typical specimen 1:2.3, 1:2.3, 1:2.1, 1:2.0, and 1:2.4, respectively.

Proloculum large, essentially spherical. Outside diameters of prolocula of 10 specimens measure 540 to 740 microns, average 620 microns. Shell expands rapidly but essentially uniformly. Heights of first to sixth volutions of four specimens 160 to 208, 350 to 450, 480 to 624, 528 to 492,

528 to 624, and 512 to 640 microns, respectively, averaging 192, 384, 560, 560, 576, and 592 microns, respectively.

Septa relatively thick, numerous. Septal counts of first to sixth volutions of one figured sagittal section 14, 31, 38, 45, 58, and 46. Septa composed of tectum and wedge-shaped layer (on posterior side of septa) that gives them appearance of pendants hanging from base of spirotheca. Septa highly, narrowly fluted; fluting extends into tectum as it passes through overlying spirotheca, as shown in accompanying photograph of a tangential section (pl. 84, fig. 1). Septal fluting forms closed chamberlets which reach almost to tops of chambers.

Spirotheca thick, composed of tectum and thick keriotheca with coarse alveoli. Thicknesses of spirotheca of first to sixth volutions of four typical specimens 32 to 40, 48 to 96, 112 to 176, 136 to 192, 136 to 168, and 80 to 121 microns, respectively, averaging 34, 64, 131, 162, 152, and 99 microns, respectively. "False walls" well-developed in second to fifth volutions of all mature specimens.

Tunnel low, broad in outer volutions. Tunnel angles of second to sixth volutions of three specimens 17 to 25, 17 to 19, 15 to 23, 18 to 22, and 31 to 38 degrees, respectively, averaging 22, 18, 18, 20, and 35 degrees, respectively. Chomata not observed. Light axial fillings occur in extreme polar regions of third and fourth volutions.

Remarks.—Although *Schwagerian chiapasensis* resembles in general features several North American Permian fusulinids, including *S. nelsoni* Dunbar and Skinner from the lower Permian Hueco limestone of Texas, *S. hessensis* Dunbar and Skinner, and *S. hawkinsi* Dunbar and Skinner both from the basal part of the Leonard, the Chiapas species is quite distinct and detailed specific comparisons seem unnecessary.

It should be pointed out that *S. chiapasensis* and the three species mentioned above are also closely similar to *S. huecoensis* (Dunbar and Skinner) from the Hueco limestone. This species is the genotype of *Pseudofusulina* Dunbar and Skinner, and it seems likely that further studies will demonstrate that it is necessary to recognize the validity of the genus *Pseudofusulina* for fusulinids closely similar to *S. huecoensis*.

Occurrence.—*S. chiapasensis* is abundant in a gray limestone member of the Grupera formation, which outcrops in the bed of the trail between La Vainilla and Palo María about ½ mile north of the Arroyo de la Grupera, that is, about 1 mile north of Palo María, Chiapas. The fusulinid-bearing limestone at this place is about 10 feet thick, and it dips about 37°, N. 10° E. It carries in addition to *S. chiapasensis* many representatives of *S. gruperaensis*, n. sp., and the two occur in close association.

Repository.—State Univ. Iowa, 3135 (figured specimens). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

SCHWAGERINA GRUPERAENSIS, Thompson and Miller, n. sp.
Plate 79, figures 1–4

Shell large, elongate, hexagonal in axial section, with essentially straight axis of coiling and sharply pointed poles. Central part of shell cylindrical, lateral slopes steep. One of largest specimens, the holotype, is probably a mature individual; it contains seven and one-half volutions, measures about 9.6 mm. in length, 4.4 mm. in width. Form ratio of this specimen 1:2.2. Form ratios of first to seventh volutions of holotype 1:2.6, 1:2.4, 1:2.3, 1:2.3, 1:2.3, 1:2.2, and 1:2.1, respectively.

Proloculum spherical, outside diameter 280 to 500 microns. Average outside diameter of prolocula of four specimens 390 microns. Shell expands uniformly, heights of first to seventh volutions of holotype 80, 128, 192, 208, 288, 368, and 400 microns, respectively. Average heights of first to seventh volutions of four other specimens 68, 111, 165, 236, 284, 240, and 304 microns, respectively.

Septa thin, numerous. Septal counts of first to seventh volutions of one sagittal section 11, 21, 21, 27, 29, 35, and 35, respectively. Septa highly, narrowly fluted throughout length of shell, fluting forms chamberlets that reach about four-fifths height of chambers. No cuneculi identified in this species.

Spirotheca composed of tectum and keriotheca with coarse alveoli. Thicknesses of spirotheca of first to seventh volutions of

holotype 22, 29, 29, 33, 60, 87, and 72 microns, respectively. As shown by these figures, spirotheca is thin throughout the shell. Average thicknesses of spirotheca in first to seventh volutions of three other specimens 18, 26, 37, 47, 58, 72, and 64 microns, respectively.

Tunnel angles of second to seventh volutions of holotype 16, 15, 15, 25, 25, and 23 degrees. Dense calcite deposits completely fill chambers in axial regions of first to sixth volutions, spread out from poles almost to tunnel, completely line chambers. These linings especially heavy in regions immediately on either side of tunnel, and almost completely fill chambers in that portion of shell.

Among the most outstanding features of this species are its distinctly hexagonal profile and the even but widespread nature of the filling of dense calcite that occurs throughout most parts of the shell.

Remarks.—*S. gruperaensis* does not closely resemble in detail any previously described species of American fusulinids. The general structure of the test resembles somewhat closely that of *S. crassitectoria* Dunbar and Skinner, but there are many differences in the details of the internal features of these two species. *S. gruperaensis* is more nearly hexagonal in cross section, has different types of fillings of the chambers, is larger at maturity, and has a larger proloculum than *S. crassitectoria*.

Occurrence.—Specimens of this species are common in a gray limestone member of the Grupera formation that outcrops in and on the sides of the trail approximately ¼ mile north of the Arroyo de la Grupera, that is, about 1 mile north of Palo María, Chiapas. At this locality it is associated with abundant specimens of *Schwagerina chiapasensis*, n. sp.

Repository.—State Univ. Iowa, 3136 (figured specimens). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

SCHWAGERINA FIGUEROAI Thompson and Miller, n. sp.
Plate 82, figures 1–4

? [F]usulinas Sapper, *1896*, Inst. Geol. México Bol. 3, p. 4.

? *Fusulina granumavenae?* Aguilera, 1897, Inst Geol. México Bols. 4–6, p. 200.

? *Fusulina* cf. *F. granumavenae* Aguilera, 1907, Cong. Géol. Intern., Xème sess., Mexico, C. R., p. 230.

Shell large, fusiform, with straight axis of coiling, sharply pointed poles. Central fifth of shell cylindrical but end portions distinctly conical. Mature specimens contain six to eight volutions, measure 12 to 15 mm. in length, 3.8 to 4.6 mm. in width, with form ratios of 1:3.2 to 1:3.3. Form ratios of first to sixth volutions of a typical specimen 1:1.7, 1:1.8, 1:2.0, 1:2.2, 1:2.6, and 1:2.8, respectively, clearly showing that length of polar regions increases more rapidly than diameter. Although central parts of shell immediately overlying tunnels are depressed in most specimens, this is apparently due entirely to crushing during fossilization.

Proloculum large, outside diameter 440 to 700 microns. Average outside diameter of prolocula of three specimens about 585 microns. Heights of first to seventh volutions of three typical specimens 94 to 130, 185 to 260, 185 to 260, 276 to 300, 333 to 370, 425 to 445, and 555 microns, respectively, averaging 116, 210, 235, 292, 357, 435, and 555 microns, respectively.

Spirotheca relatively thick, composed of tectum and keriotheca with coarse alevoli. Thicknesses of spirotheca of first to seventh volutions of three typical specimens 16, 24 to 33, 30 to 50, 33 to 67, 50 to 83, 83 to 100, and 100 to 133 microns, respectively, averaging 16, 27, 38, 53, 69, 91, and 116 microns, respectively. Alveoli of keriotheca coarse. In typical specimen lower part of alveoli in sixth volution measures about 20 microns in diameter.

Septa thin, numerous, intensely fluted throughout length of shell; chamberlets formed by fluting closed for more than half height of chambers. One typical specimen has 16, 27, 36, 32, 36, and 32 septa in first to sixth volutions, respectively.

Tunnel low, narrow in inner volutions, very poorly developed in sixth, seventh, and eighth volutions of mature specimens. All axial sections obtained are of specimens faulted or slightly crushed along general line of tunnel; true value of tunnel angle in any part of the shell not accurately determinable. However, tunnel angle slightly

more than 30 degrees in sixth and seventh volutions of a typical specimen. Deposits of dense calcite thinly line inside of chambers in extreme axial regions of first six volutions of specimens of eight volutions, completely line and essentially fill inside of chambers in areas immediately adjacent to tunnel of first to fifth or sixth volutions of mature specimens, giving appearance of very heavy and broad chomata. Chomata not observed in any portion of shell of this species.

Remarks.—*S. figueroai* resembles *S. diversiformis* Dunbar and Skinner of the "Hueco limestone" of the Franklin Mountains, Texas, more closely than any other described American fusulinid. In fact, many of the purely statistical data of these two species are essentially the same. However, the proloculum of *S. diversiformis* is consistently much smaller than that of *S. figueroai*, and the lateral slopes of the latter species are distinctly concave whereas those of *S. diversiformis* are convex. The most outstanding difference between specimens of these two species is that the axial fillings of *S. figueroai* are very heavy near the tunnel regions in the inner five to six volutions, whereas the axial fillings of *S. diversiformis* are confined to the axial regions and do not occur near the tunnel, especially in the inner four to five volutions. Of course, the close similarity between these two forms suggests they are not greatly different in age.

This species is named in honor of Señor Arnulfo Figueroa F., Superintendent of Schools of Chicomuselo, who showed us many courtesies during our stay at his home.

Occurrence.—*S. figueroai* is common in the type section of the La Vainilla limestone near the top of the limestone cliff on the north wall of the valley of the Arroyo de la Grupera in southeastern Chiapas. Our collections were obtained from the sides of the trail near the top of the cliff, about ¾ mile north of the crossing of the Arroyo de la Grupera and about ¾ mile south of La Vainilla, that is, almost 1½ miles north of Palo María. Associated with this form are numerous specimens of brachiopods and other fossils.

Repository.—State Univ. Iowa, 3137 (figured specimens). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

SCHWAGERINA sp. A
Plate 79, figure 12

Limestone samples in one of our collections from the upper member of the Paseo Hondo formation of southern Chiapas are composed largely of specimens of *Schubertella mullerriedi*, n. sp., and scattered specimens of a species referable to the genus *Schwagerina*. We have obtained more than half a dozen sections of the latter, but none of them is well centered and well oriented throughout the length of the shell. Although the massive limestone stratum from which these samples were collected does not show any evidence of faulting on the exposures, thin sections reveal that it has been cut by innumerable small faults with displacements as small as a fraction of a millimeter, and in almost all of our sections of the form under consideration portions of the shell are missing or are off-set by faults.

We do not feel certain our data concerning this form are complete nor that we can determine with certainty its specific affinities. However, for the sake of completeness we illustrate one of our axial sections and have drawn up the following description, based on ten thin sections.

Shell of medium size, elongate fusiform, with bluntly pointed poles, essentially straight axis of coiling, broadly convex lateral slopes. Largest specimens composed of six volutions, measure about 9.5 mm. in length, 2.5 mm. in width, giving form ratio of about 1:3.8. Poles of this form become more highly extended during ontogenetic development. Form ratios of first to fourth volutions of one specimen 1:2.0, 1:2.6, 1:3.0, and 1:3.0, respectively, showing gradual extension of poles.

Proloculum essentially spherical, outside diameter 340 to 420 microns in four specimens, averaging about 380 microns. Shell expands uniformly, average heights of first to sixth volutions of six specimens 91, 133, 208, 266, 304, and 320 microns, respectively.

Septa thin, numerous, narrowly and highly fluted throughout length of shell; fluting forms closed chamberlets almost to top of chambers. Septal count not determined.

Spirotheca relatively thin, composed of

tectum and keriotheca. Average thicknesses of spirotheca in first to sixth volutions of two specimens 29, 36, 38, 56, 63, and 91 microns, respectively.

Tunnel very low, broad. Tunnel angles of first to sixth volutions of one specimen 17, 25, 40, 46, 54, and 54 degrees, respectively. Chomata not observed in this species. Chambers in axial regions of inner three to four volutions partly filled with dense calcite.

Remarks.—The proloculum of this form is very large and the septa are very highly fluted as in many representatives of *Parafusulina*. However, we have not observed any sign of cuneculi in any tangential surface during the preparation of sections. Since our detailed information is so meager, we are not able to make detailed specific comparisons with previously described species. However, this form obviously is not conspecific with any of the other species we are here describing from Chiapas.

Occurrence.—The specimens here described and illustrated were obtained from the upper limestone member of the Paseo Hondo formation on the bluff south of the north trail between Portales and Paseo Hondo, about 3.5 miles east of Portales and just west of the eastern of the two high passes between Portales and Paseo Hondo. The elevation of the trail at this point is about 850 meters.

Repository.—State Univ. Iowa, 3138 (figured specimen). Other specimens are being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

SCHWAGERINA sp. B
Plate 81, figure 1

We have one well-oriented axial section of a species of *Schwagerina* which differs markedly from the other representatives of that genus known from Central America and which undoubtedly represents a new species. We have prepared numerous thin sections of the limestone which produced this specimen but have not been able to obtain additional sections of this form. Although we feel quite certain this specimen represents an undescribed species, we hesitate to propose a new name for a single specimen. However, for the sake of completeness, we are illustrating this axial section, and we have drawn up the following description of it.

Shell large, uniformly fusiform, with sharply pointed poles and straight axis of coiling. The specimen consists of six and one-half volutions, measures about 8.0 mm. in length, about 4.5 mm. in width, form ratio about 1:1.78. Form ratios of first to fifth volutions about 1:1.4, 1:1.7, 1:1.8, 1:1.7, and 1:1.7, respectively, showing that mature shape of shell is first attained in second volution. General curvature of lateral slopes and of surface of central part of shell markedly convex, essentially similar throughout length of shell.

Proloculum spherical, outside diameter about 560 microns. Shell expands at essentially uniform rate during first five volutions, heights of first to sixth volutions about 100, 220, 315, 410, 470, and 400 microns, respectively.

Spirotheca thick composed of tectum and thick keriotheca with coarse alveoli. Thicknesses of spirotheca of first to sixth volutions about 8, 15, 30, 45, 45, and 30 microns, respectively. Although we have no sagittal section of this species, it can be determined from axial section that septa are thin, very narrowly and highly fluted throughout length of shell. Fluting extends to tops of chambers, apparently forms closed chamberlets about four-fifths height of chambers.

Tunnel narrow, low. Tunnel angles of second to fifth volutions measure 22, 15, 12, and 17 degrees, respectively. Very thin irregular deposits of dense calcite border tunnel in third to fifth volutions but do not form definite structures like chomata. Deposits of dense calcite fill chambers in polar regions of all volutions shown in specimen. However, region in which axial fillings occur is confined to immediate axial area.

Remarks.—Although we are not able to determine all of the specific characters of this form from our single section, the information we have obtained indicates it is similar in general features to *Schwagerina hawkinsi* Dunbar and Skinner, originally reported from the "Leonard formation" on Dugout Mountain, Texas. However, the Texas species does not have the axial fillings that are so pronounced in our specimen.

These two species also differ markedly in detail.

Occurrence.—The single thin section was obtained from the light to medium gray limestone which we are referring to the La Vainilla limestone and which forms the cliffs on the northwest side of a northeast-flowing tributary of the Río de Santo Domingo about 3 miles south (and possibly somewhat east) of Paseo Hondo, Chiapas. It is associated with the fusulinids described in this report as *Schwagerina* sp. C and *Paraschwagerina roveloi*, n. sp.

Repository.—State Univ. Iowa, 3139

SCHWAGERINA sp. C
Plate 79, figure 13

Several thin sections of limestone in one of our collections from Chiapas contain specimens of a species of fusulinid that differs from any of the others we have from that area. Only one of our sections is well oriented and centered and it is obviously of an immature specimen, for several oblique sections of other conspecific specimens contain more volutions than does this well-oriented section. We are unable to determine many of the significant specific characters from the sections we have, but for the sake of completeness we are illustrating our best section, and we have drawn up the following description, which is based on all available material.

Shell of medium size, elongate fusiform, with broadly rounded to bluntly pointed poles and essentially straight axis of coiling. Central part of shell cylindrical. Lateral slopes in polar regions steep but strongly convex. Our well oriented specimen measures 5.8 mm. in length, 2.3 mm. in width, consists of at least six volutions. Form ratios of first to sixth volutions 1:1.7, 1:2.2, 1:2.5, 1:2.5, 1:2.5, and 1:2.5, respectively.

Proloculum spherical, outside diameter of proloculum of figured specimen 280 microns. Shell expands uniformly, at least for first six volutions, heights of first to sixth volutions of illustrated specimens 40, 90, 150, 185, 275, and 260 microns, respectively. However, central portion of this specimen is slightly compressed and measurements are probably somewhat less than true heights.

Spirotheca thin, composed of tectum and keriotheca with coarse alveoli. Thicknesses of spirotheca of first to sixth volutions of figured section 15, 20, 25, 33, 67, and 50 microns, respectively. Septa narrowly, highly fluted throughout length of shell, fluting intense to top of chambers but forms closed chamberlets, only about four-fifths height of chambers.

Tunnel low, broad. Tunnel angles of fourth to sixth volutions of figured section 21, 36, and 31 degrees, respectively. Axial regions heavily filled with dense calcite that spreads out, fills chambers of at least two-thirds entire shell; chambers free of these fillings only in central part of shell near tunnel.

Occurrence.—This species occurs in a highly fossiliferous massive to massively bedded gray to medium-gray limestone which we are referring to the La Vainilla limestone and which forms cliffs on the northwest side of a northeast-flowing tributary of the Río de Santo Domingo about 3 miles south (and possibly somewhat east) of Paseo Hondo. It is associated with the forms described in this report as *Schwagerina* sp. B and *Paraschwagerina roveloi*, n. sp., and with abundant algae, corals, and brachiopods.

Repository.—State Univ. Iowa, 3140 (figured specimen). Other specimens are divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Genus PARASCHWAGERINA Dunbar and Skinner

The genus *Paraschwagerina* was established by Dunbar and Skinner in 1936, and *Schwagerina gigantea* White from the Wolfcamp of Texas was designated as the genotype. This genotype has a minute proloculum, and it contains a tightly coiled juvenarium which has a small form ratio and which is sharply set off from the much more highly expanded outer volutions. The septa of the genotype are moderately closely spaced and they are highly and narrowly fluted throughout the length of the shell. In fact, the fluting of the septa extends into the spirotheca at the top of the chambers and forms closed chamberlets that reach almost to the tops of the chambers. The shell of *P. gigantea* is inflated fusiform and has a form ratio of 1:2.5 to 1:3.5. In addi-

tion to the genotype, Dunbar and Skinner included the following species in the genus: *Schwagerina alternans* Schellwien [age not known], *Fusulina dussaulti* Deprat ["Ouralian"], *S. yabei* Staff [lower Guadalupian], *S. kansasensis* Beede and Kniker [Wolfcampian], *S. oblonga* Ozawa ["*Sumatrina* subzone"], *S. tinvenkiangi* Lee [upper Taiyuan], and *S. fosteri* Thompson and Miller [Middle Permian?]. We do not consider *S. alternans* Schellwien closely related to the genotype of *Paraschwagerina* and therefore do not think it referable to that genus. Since 1936 several additional species have been described that would be referred to the genus *Paraschwagerina* as that genus is generally defined; these include *P. acuminata* Dunbar and Skinner from the Wolfcamp of Oklahoma.

The genus *Paraschwagerina*, as now defined, contains a wide variety of fusulinids and it is not composed of a closely similar group of species. The highly fusiform elongated species, *Schwagerina gigantea* White with highly fluted septa, represents one extreme group of species generally referred to *Paraschwagerina*. The ellipsoidal highly inflated species, *Schwagerina yabei* Staff, with highly inflated chambers and septa that are fluted only in their lower part, represents another group of species generally referred to the same genus.

The species *P. kansasensis*, *P. acuminata*, *P. fosteri*, and *P. yabei*, are closely similar and presumably are closely related biologically, but they vary in stratigraphic age from lower Wolfcampian to lower Guadalupian. Of the other species of *Paraschwagerina* mentioned above, the stratigraphic ages of *F. dussaulti* Deprat and *S. oblonga* Ozawa are not definitely known; and it should be mentioned that the exact nature of the internal features of these species is poorly known and they may not belong in *Paraschwagerina*. *S. tinvenkiangi* Lee occurs in the upper part of the Taiyuan series of northern China. This species seems to be more closely similar to *S. fosteri* than to the genotype of *Paraschwagerina*, *S. gigantea*.

One of our collections from Chiapas contains numerous specimens of an undescribed species that is more closely similar to *P. gigantea* than to any other genotype. We are referring it to the genus *Paraschwagerina*, and we are describing it below as *P. roveloi*, n. sp. This form is so very closely similar to *P. gigantea* that we feel there is no doubt that it is referable to the genus *Paraschwagerina*. In fact, it is more closely similar to *P. gigantea* than are most other species generally referred to this genus.

PARASCHWAGERINA ROVELOI Thompson and Miller, n. sp.
Plate 80, figures 1, 2;
plate 82, figures 5, 6

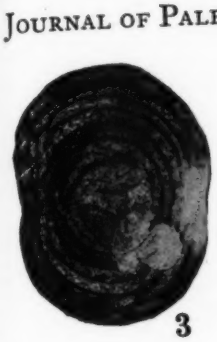
Shell large, highly inflated fusiform, with sharply pointed poles, irregular axis of coiling, and irregular lateral slopes. Mature specimens contain eight to nine volutions, measure 8.5 to 10.4 mm. in length, 3.7 to 5.2 mm. in width. Mature shape of shell first attained in about fourth or fifth volution. Form ratios of mature specimens 1:2.1 to 1:2.0. Form ratios of first to seventh volutions of a typical specimen 1:1.8, 1:3.8, 1:3.3, 1:2.6, 1:2.0, and 1:1.9, respectively. In second to sixth volutions, axial regions lengthen very rapidly so that each volution in this portion of shell far overlaps preceding volution.

Proloculum minute, outside diameter 80 to 90 microns. Average outside diameter of three specimens 85 microns. Inner two to three volutions very tightly coiled, next one or two volutions only slightly more highly inflated. Beyond fourth volution shell highly inflated, outer three to five volutions of essentially same height. Heights of first to eighth volutions of three typical specimens 34 to 51, 44 to 51, 68 to 83, 116 to 204, 300 to 583, 466 to 616, 500 to 633, 483, and 500

EXPLANATION OF PLATE 83

FIGS. *1*, *2*—*Schwagerina chiapasensis* Thompson and Miller, n. sp. *1*, Axial section; *2*, sagittal section; both ×10. Grupera formation about 1 mile north of Palo María, Chiapas. (p. 494)

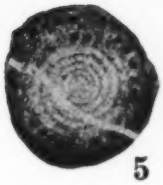
3–7—*Eoverbeekina americana* Thompson and Miller, n. sp. *4*, *7*, Axial section of holotype, ×10 and ×20; *5*, sagittal section of a paratype, ×10; *3*, *6*, axial section of a paratype, ×10 and ×20. Paseo Hondo formation about 3½ miles south of Paseo Hondo (figs. *3*, *6*) and about 3 miles east of Portales (figs. *4*, *5*, *7*), Chiapas. (p. 492)



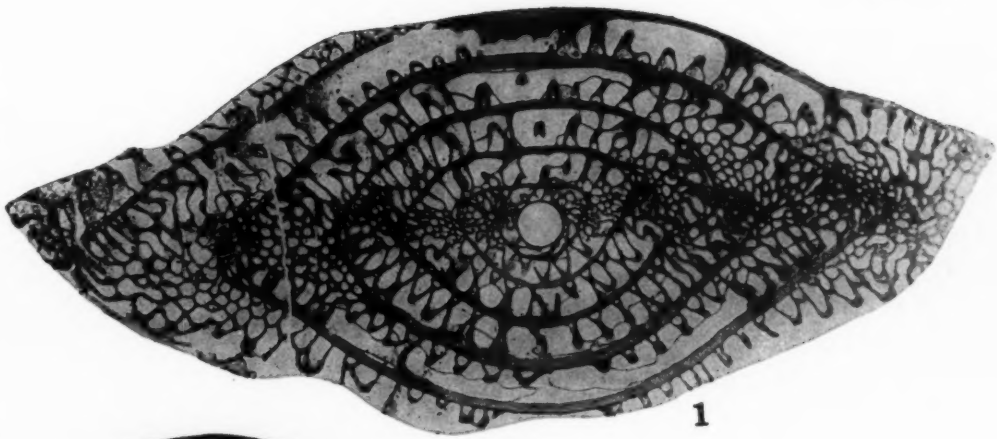
3

2

4



5

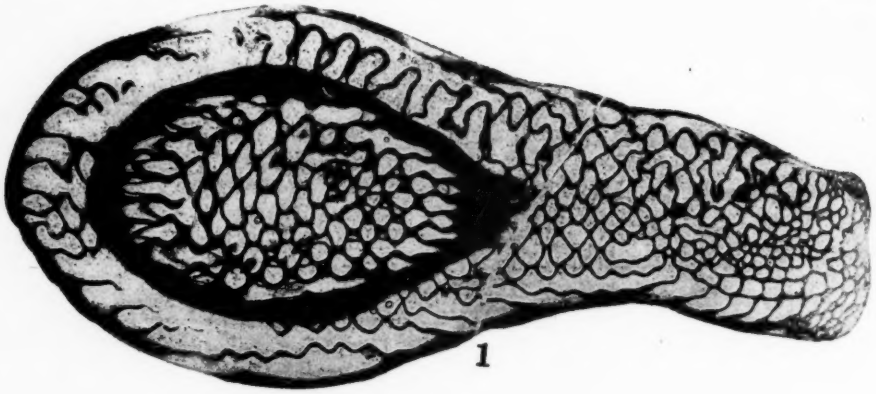


1

6

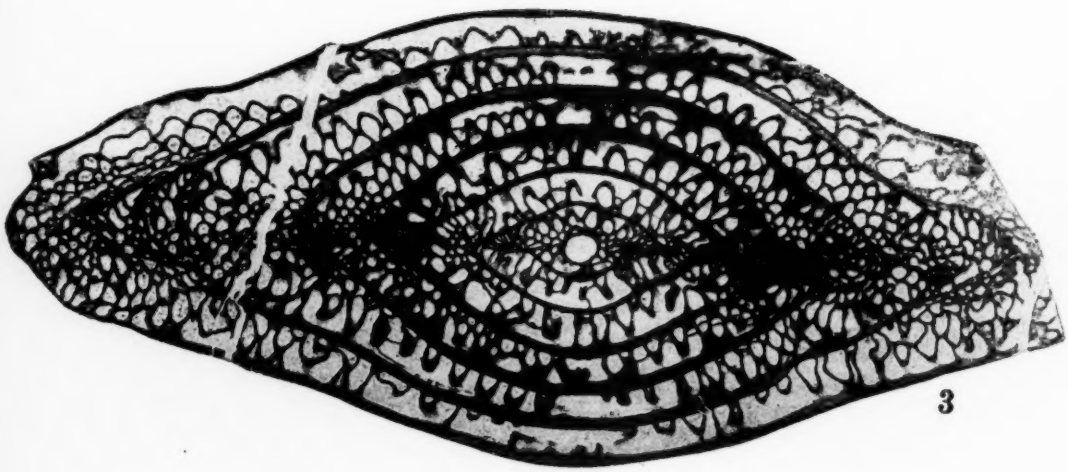
7

Thompson and Miller – Permian Fusulines



1

2



3

Thompson and Miller – Permian Fusulines

microns, respectively, averaging 42, 48, 76, 163, 489, 538, 544, 483, and 500 microns, respectively, showing that outer two volutions become somewhat more tightly coiled in gerontic individuals.

Septa thin, numerous. Septal counts of first to ninth volutions of figured sagittal section 9, 15, 20, 19, 18, 30, 38, 49, and 55, respectively. Septa very thin in polar regions, but immediately over tunnel contain solid beveled layer on posterior side of tectum. Septa narrowly fluted throughout length of shell, fluting extends up into spirotheca. Chamberlets formed by fluting extend almost to top of chambers.

Spirotheca composed of tectum and keriotheca with coarse alveoli. In inner four volutions spirotheca very thin. From fourth to sixth volution thickness of spirotheca increases rapidly. Spirotheca of sixth to ninth relatively thick. Thicknesses of spirotheca near middle of chambers in second to ninth volutions of illustrated sagittal section about 8, 17, 24, 50, 125, 183, 167, and 167 microns, respectively.

Tunnel low, broad. In a typical specimen tunnel angle about 24 degrees in third volution, 40 degrees in fourth, 33 degrees in fifth, 24 degrees in sixth, 21 degrees in seventh, 22 degrees in eighth volution. Low, essentially symmetrical chomata border tunnel in second to fifth volutions; discontinuous low chomata observed in all other volutions except outer portion of outermost volution.

Remarks.—*P. roveloi* resembles *P. gigantea* (White) more closely than any described species of *Paraschwagerina*. However, *P. roveloi* has a smaller shell at maturity, a juvenarium with a different shape and size, much thicker spirotheca for corresponding portions of the shell, and a septal count in the medial portion of the shell different from that in *P. gigantea* (White).

This species is named in honor of Don Javier Rovelo of the Hacienda Chejel, in appreciation of his hospitality and material assistance given to us while in his area.

Occurrence.—Specimens of *P. roveloi* are common in a highly fossiliferous massive to massively bedded gray limestone member of the La Vainilla limestone which forms the cliffs on the northwest side of a northeast-flowing tributary of the Río de Santo Domingo about 3 miles south (and possibly somewhat east) of Paseo Hondo. It is associated with the forms described in this report as *Schwagerina* sp. B and *S.* sp. C and with very abundant algae, horn corals, and brachiopods.

Repository.—State Univ. Iowa, 3141 (figured specimens). Remainder of the type material is being divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

Genus PARAFUSULINA Dunbar and Skinner

The genus *Parafusulina* was established by Dunbar and Skinner in 1931, and *P. wordensis* Dunbar and Skinner from the lower Guadalupian Word formation was designated as the genotype. These workers pointed out, among other things, the presence of small openings in the base of the septa, called foramina, that are formed by the intense fluting of the septa lifting the base of the septa off the spirotheca of the preceding volution. These openings are joined from septum to septum by the overlying fluted septa to form small spiral funnel-like paths, cuneculi. The septa that border these cuneculi are joined so as to form unbroken wavy walls that are essentially normal to the axis of coiling of the shell. Other noticeable features of the genotype are the large size and the highly elongate subcylindrical shape of the shell. From a study of topotype specimens of the genotype, descriptions and illustrations of the genosyntypes, descriptions and illustrations of more than three dozen species of the genus, and the type specimens of the Chiapas species described below, we have drawn up the following generic diagnosis of the genus *Parafusulina*.

Shell large, highly elongate cylindrical to

EXPLANATION OF PLATE 84

FIGS. *1–3*—*Schwagerina chiapasensis* Thompson and Miller, n. sp. *1*, Tangential section; *2*, sagittal section; *3*, axial section; all ×10. Grupera formation about 1 mile north of Palo María, Chiapas. (p. 494)

subcylindrical, with straight, irregular, to broadly curving axis of coiling and sharply pointed to broadly rounded poles. Mature specimens consist of seven to ten volutions. Mature specimens of different species vary considerably in size, most are large. Some described species measure more than 30 mm. in length, 5 mm. in width. Mature specimens of other species as small as 9 mm. in length and 3 mm. in width. Innermost volution of mature specimens of most species contains short axis of coiling, but beyond second volution axis increases in length rapidly. Mature shape of shell reached in fourth or fifth volution of most species. Form ratios of mature specimens of most species range between 1:3.5 and 1:6.0.

Prolocula of almost all known species spherical to irregular subspherical, inside diameters measure from 300 to more than 600 microns. Shell expands essentially uniformly up to fifth or sixth volution. Beyond this stage chambers remain of essentially same height, or shell may become slightly more tightly coiled in outer volutions.

Septa thin, essentially normal to lower surface of spirotheca, narrowly and highly fluted throughout length of shell, fluting so intense that it forms chamberlets closed almost to tops of chambers. Basal parts of septa so intensely fluted that fluting lifts septa off the spirotheca of preceding volution, forms small openings (foramina) that connect alternate chambers. Sides of foramina bordered by joined portions of adjacent septa that give appearance of wavy walls bordering small spiral tunnel, the cuneculi. Therefore, tangential sections that intersect basal part of chambers give appearance of transverse septa bordering paths of cuneculi. A well developed tunnel occurs in all portions of shell except outer part of outermost volution. Axial fillings occur in polar regions of practically all species, varying greatly in development, and are extremely heavy in some species referred to this genus.

Spirotheca relatively thin, composed of tectum and keriotheca with coarse alveoli. Thickness in outermost volutions of mature specimens rarely exceeds 120 microns.

Some of the outstanding features of representatives of *Parafusulina* are the highly elongated subcylindrical shape of the shell, very large size of mature specimens, large proloculum, uniformly expanding shell, intensely fluted septa that form cuneculi connecting alternate chambers, and axial fillings that occur in the polar regions.

Representatives of the genus *Polydiexodina* may be distinguished from those of the genus *Parafusulina* by the presence of multiple tunnels in *Polydiexodina*. Also, specimens of *Polydiexodina* are, in general, more slender and much longer than specimens of *Parafusulina*. Representatives of *Parafusulina* differ from those of *Schwagerina* by the presence of foramina (and therefore cuneculi), the larger size of mature specimens, more highly elongate and more nearly cylindrical shells of mature specimens, and relatively thinner spirotheca in species of the former genus. However, no single one of these criteria can be used to distinguish all species of either of these genera.

The genus *Parafusulina* has been recorded in North America only from the upper part of the so-called Leonard series and the lower part of the Guadalupian series. However, in Eurasia congeneric forms may possibly occur stratigraphically higher than in America. The type specimens of the most primitive species of *Parafusulina* previously described from America were obtained near the middle of the Leonard formation. However, that form is, in reality, highly developed, and it indicates that *Parafusulina* originated at a considerably earlier geologic time. In 1931 Gerth described and illustrated a fusulinid as "*Fusulina* cf. *verneuili* v. Möller" from Paso Palmerito in the southern part of Cordillera de Mérida, Venezuela. Although the generic affinities of that form can not be determined from Gerth's illustration and description, it may well be referable to the genus *Parafusulina*.

One of our collections from Chiapas contains abundant specimens of a primitive species of *Parafusulina* that we are describing below as *P. australis*, n. sp. Although it is not closely similar to any known American species of the genus, it does suggest that the Central American strata in which it occurs are not greatly older stratigraphically than the middle portion of the Leonard formation which yielded the most primitive previously described American species of *Parafusulina*.

PARAFUSULINA AUSTRALIS Miller and Thompson, n. sp.
Plate 81, figures 2–9

Shell of medium size, elongate fusiform, with sharply pointed poles and essentially straight axis of coiling. Central half of shell almost perfectly cylindrical, end fourths distinctly conical with steep lateral slopes. Mature specimens consist of eight volutions, measure 9.0 to 11.0 mm. in length and 3.3 to 4.0 mm. in width. Form ratios of first, third, fifth, sixth, seventh, and eighth volutions of a typical specimen 1:2.5, 1:2.1, 1:2.2, 1:2.0, 1:3.0, and 1:2.8, respectively. Shell of inner three to four volutions essentially same general shape as that of outer volutions of mature individuals.

Proloculum spherical, outside diameter 200 to 360 microns in eight specimens, averaging 280 microns. Shell expands in size uniformly, heights of first to eighth volutions of four specimens 41 to 81, 83 to 135, 117 to 150, 150 to 183, 167 to 250, 200 to 267, 216 to 366, and 283 to 416 microns, respectively, averaging 56, 96, 106, 167, 204, 246, 287, and 350 microns, respectively.

Spirotheca relatively thin, composed of tectum and heriotheca with coarse alveoli. Thicknesses of spirotheca of first to eighth volutions of three typical specimens 17, 17 to 24, 20 to 24, 24 to 27, 27 to 44, 48 to 51, 71, and 75 microns, respectively, averaging 17, 19, 23, 25, 36, 50, 71, and 75 microns, respectively.

Septa thin, numerous. Septal counts of first to eighth volutions of figured sagittal sections 15, 21, 26, 28, 30, 40, and 42, respectively. Septa narrowly, highly fluted throughout length of shell. Fluting forms essentially circular chamberlets closed off for about two-thirds to three-fourths height of chambers even immediately over tunnel. Fluting of septa extends to top of chambers, tectum of septa broadly undulated even as it passes through spirotheca.

Tunnel low, narrow in inner three to four volutions, becomes very broad in outer volutions. Tunnel angles of third, fourth, fifth, sixth, seventh, and eighth volutions of three typical specimens 18, 22 to 25, 22 to 30, 22 to 39, 27 to 39, and 32 to 37 degrees, respectively, averaging 18, 23, 25, 30, 35, and 35 degrees, respectively. Very low, essentially uniform chomata border tunnel in inner two volutions, none observed in outer part of shell. Chambers of inner four volutions of specimens of more than five volutions filled with dense deposits of calcite from area adjacent to tunnel to poles. However, beyond fourth volution these deposits poorly developed, occur mainly in extreme polar regions.

Remarks.—This species is being referred to the genus *Parafusulina* largely because of the presence of cuneculi in the lower part of its septa. However, the cuneculi are not large and can be observed in only favorably cut parallel sections. This form obviously is a primitive representative of the genus *Parafusulina*.

P. australis does not closely resemble any previously described species of *Parafusulina*. In general appearance it is similar to several species of *Schwagerina*, including *S. crassitectoria*, *S. guembeli*, and *S. franklinensis*, but it can be distinguished from these forms by several characters other than the recognized presence of cuneculi in its test. In respects other than septal fluting, *P. australis* contains much heavier axial filling than *S. franklinensis*. *P. australis* is larger at maturity, has a larger number of volutions at maturity, and has a smaller form ratio than either *S. guembeli* or *S. crassitectoria*. As can be observed by a comparison of published illustrations of *S. guembeli* and *S. crassitectoria* with those of *P. australis* here given, the general shape of the shell of the latter is different from that of the two North American species of *Schwagerina*, especially in the more sharply pointed poles of *P. australis*.

Occurrence.—*P. australis* is very abundant in a medium-gray massive limestone that occurs in the lower portion of the Paseo Hondo formation of southern Chiapas. Our specimens were collected in the southeast valley wall of a northeast-flowing tributary of the Río de Santo Domingo about 3½ miles south (and possibly somewhat east) of Paseo Hondo.

Repository.—State Univ. Iowa, 3142 (figured specimens). Remainder of the type material is divided among the State University of Iowa, the University of Kansas, and the Universidad Nacional de México.

BIBLIOGRAPHY

AGUILERA, J. G., 1897, Sinopsis de geología Mexicana: Inst. Geol. México Bols. 4–6, pp. 187–250.

——, 1907, Aperçu sur la géologie du Mexique pour servir d'explication à la carte géologique de l'Amérique du Nord: Cong. Géol. Intern., Xème sess., Mexico, C. R., pp. 227–248.

BAKER, C. L., 1930, Geological cross-section of Isthmus of Tehuantepec: Pan-Am. Geologist vol. 53, pp. 161–174.

BÖSE, EMIL, 1905, Reseña acerca de la geología de Chiapas y Tabasco: Inst. Geol. México Bol. 20, pp. 5–100, pls. 1–9.

COLANI, M., 1924, Nouvelle contribution à l'étude des fusulinidés de l'Extrême-Orient: Serv. géol. Indochine Mém., tome 11, fasc. 1, pp. 1–191, pls. 1–29.

DOLLFUS, AUGUSTE, and MONT-SERRAT, EUG. DE, 1868, Voyage géologique dans les républiques de Guatemala et de Salvador: [France] Mission Scientifique au Mexique et dans l'Amérique centrale, Géologie, pp. 1–539.

DUNBAR, C. O., 1939, Permian fusulines from Central America: Jour. Paleontology, vol. 13, pp. 344–348, pls. 35, 36.

——, 1939, Permian fusulines from Sonora: Geol. Soc. America Bull., vol. 50, pp. 1745–1760, pls. 1–4.

DUNBAR, C. O., HENBEST, L. G., and WELLER, J. M., 1942, Pennsylvanian Fusulinidae of Illinois, with a section on stratigraphy: Illinois Geol. Survey Bull. 67, pp. 1–218, pls. 1–23.

DUNBAR, C. O., and SKINNER, J. W., 1931, New fusulinid genera from the Permian of west Texas: Am. Jour. Sci., 5th ser., vol. 22, pp. 252–268, pls. 1–3.

——, 1936, *Schwagerina* versus *Pseudoschwagerina* and *Paraschwagerina:* Jour. Paleontology, vol. 10, pp. 83–91, pls. 10, 11.

——, 1937, Permian Fusulinidae of Texas: Texas Univ. Bull. 3701, pp. 517–825, pls. 42–81.

GERTH, H., 1931, Neue Vorkommen von marinen Obercarbon in den nördlichen Anden: Neues Jahrb., 1931, Beilage-Band. 65, Abt. B, pp. 521–529, pls. 22, 23.

KING, R. E., 1940, Paleozoic stratigraphy of Mexico: Eighth Am. Sci. Cong. Proc., vol. 4, pp. 109–119.

LEE, J. S., 1931, Distribution of the dominant types of fusulinoid Foraminifera in the Chinese seas: Geol. Soc. China Bull., vol. 10, pp. 273–290, pl. 1.

——, 1933, Taxonomic criteria of Fusulinidae, with notes on seven new Permian genera: Nat. Research Inst. Geology [Shanghai] Mem., vol. 14, pp. 1–32, pls. 1–5.

LICHAREW, BORIS, ET AL., 1939, The atlas of the leading forms of the fossil fauna USSR, vol. 6, Permian: Cent. Geol. and Prosp. Inst. [Leningrad], pp. 1–270, pls. 1–56.

MILLER, A. K., and FURNISH, W. M., 1941, Ammonoides Permeanas de la parte más meridional de México: Soc. Geol. Mexicana Bol., tomo 11, nos. 1–6, pp. 77–85, pl. 1.

MÖLLER, VAL. VON, 1877, Ueber Fusulinen und ähnliche Foraminiferen-Formen des russischen Kohlenkalkes: Neues Jahrb., Jahrg. 1877, pp. 139–146.

——, 1878, Die spiral-gewundenen Foraminiferen des russischen Kohlenkalks: Acad. Imp. Sci. St. Pétersbourg Mém., 7e sér, tome 25, no. 9, pp. 1–147, pls. 1–15.

MUIR, J. M., 1936, Geology of the Tampico region, Mexico: Am. Assoc. Petroleum Geologists Spec. Pub., pp. 1–280, pls. 1–19.

MÜLLERRIED, F. K. G., 1930, Informe preliminar de la exploración geológica del Estado de Chiapas, durante los años de 1927, 1928, y 1929: Inst. Geol. México Foll. divulg., no. 36, pp. 1–16.

——, 1936, Estratigrafía preterciaria preliminar del Estado Chiapas: Soc. geol. mexicana Bol., tomo 9, no. 1, pp. 31–34.

MULLERRIED, F. K. G., MILLER, A. K., and FURNISH, W. M., 1941, The Middle Permian of Chiapas, southernmost Mexico, and its fauna: Am. Jour. Sci., vol. 239, pp. 397–406, pl. 1.

OZAWA, Y., 1925, On the classification of Fusulinidae: Tokyo Imp. Univ., Col. Sci. Jour. vol. 45, pp. 1–26, pls. 1–4.

SAPPER, KARL, 1894, Grundzüge der physikalischen Geographie von Guatemala: Petermanns Mitt. Erg. 113, pp. 1–59, pls. 1–4.

——, 1894, Informe sobre la geografía física y la geología de los Estados de Chiapas y Tabasco: Agr. Min. é Ind. Bol. 3, no. 9, pp. 187–211.

——, 1896, Sobre la geografía física y la geología de la península de Yucatán: Inst. geol. mexicana Bol. 3, pp. 1–57, pls. 1–6.

——, 1899, Über Gebirgsbau und Boden des nördlichen Mittelamerika: Petermanns Mitt. Erg. 127, pp. 1–119, pls. 1–5.

——, 1937, Mittelamerika, unter Mitarbeit von Privatdozent Dr. Walther Staub, Bern: Handb. region. Geol., Bd. 8, 4a, Heft 29, pp. 1–160, pls. 1–10.

SCHUCHERT, CHARLES, 1935, Historical geology of the Antillean-Caribbean region or the lands bordering the Gulf of Mexico and the Caribbean Sea, pp. 1–811, pls. 1–16.

STAFF, H. VON, 1912, Monographie der Fusulinen, Theil III, Die Fusulinen (Schellwienien) Nordamerikas: Palaeontographica, Band 59, pp. 157–192, pls. 15–20.

STAFF, H. VON, and WEDEKIND, RUDOLF, 1910, Der oberkarbone Foraminiferen-Sapropelit Spitzbergens: Upsala Univ., Geol. Inst. Bull., Bd. 10, pp. 81–123, pls. 2–4.

THOMPSON, M. L., 1935, The fusulinid genus *Staffella* in America: Jour. Paleontology, vol. 9, pp. 111–120, pl. 13.

——, 1937, Fusulinids of the subfamily Schubertellinae: Jour. Paleontology, vol. 11, pp. 118–125, pl. 22.

——, 1942, New genera of Pennsylvanian fusulinids: Am. Jour. Sci., vol. 240, pp. 403–420, pls. 1–3.

THOMPSON, M. L., and FOSTER, C. L., 1937, Middle Permian fusulinids from Szechuan, China: Jour. Paleontology, vol. 11, pp. 126–144, pls. 23–25.

WAIBEL, LEO, 1933, Die Sierra Madre de Chiapas: Geog. Gesell. Hamburg Mitt., Band. 43, pp. 12–154.

MANUSCRIPT RECEIVED SEPTEMBER 3, 1943.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 505–528, PLS. 85–88, NOVEMBER 1944

OSTRACODA FROM THE DUPLIN MARL (UPPER MIOCENE) OF NORTH CAROLINA[1]

RICHARD A. EDWARDS
University of Florida

ABSTRACT.—Ostracods from the Duplin marl were collected at three localities in North Carolina. The fauna consists of 20 genera, one subgenus, 35 species and 4 varieties of which two genera, 29 species and 3 varieties are described as new. A few additional species represented by an inadequate number of specimens are not described.

THE OSTRACODA described in this report were obtained from samples of the Upper Miocene Duplin marl from localities in North Carolina. Stratigraphically the Duplin is equivalent to the upper part of Yorktown zone 2 in Virginia and to the upper part of the *Cancellaria* zone of the Choctawhatchee formation in Florida (Mansfield, 1936, p. 173). The Middle Miocene Ostracoda of Maryland and Virginia have been described by Ulrich and Bassler (1904) while Howe and others (1935) have described those of Florida.

Available exposures of the Duplin marl are found in two areas of the state, one in the vicinity of the type locality at Natural Well and the other in the neighborhood of Lumberton and Fairmont. The ostracod faunas suggest, however, that the exposures in these two areas are neither time nor environmental equivalents. MacNeil (1937, p. 19) has concluded that the Lumberton exposures are the younger but at present, there does not appear to be sufficient information concerning the evolutionary trends of Miocene Ostracoda to be certain.

Several outcrops of the Duplin marl have been recorded, but because of obliteration of exposures or poor preservation of the fossils, specimens are described from only three localities. At locality 1, Natural Well near Magnolia, Duplin County, the Duplin is a highly fossiliferous marl about 3 feet thick, overlying, with slight unconformity, a greenish, calcareous, argillaceous sand which contains no macrofossils, but whose ostracod fauna shows definite Eocene affinities. Locality 2 (U. S. Geol. Survey loc. 11820) is a marl pit on Mr. A. R. Chesnut's farm 3 miles southwest of Kenansville, Duplin County. At the time this place was visited the marl was partially covered with water, so that its thickness could not be measured. Locality 3, near Lumberton, Robeson County, N. C., is a pit on the west side of U. S. Highway 74 and on the north side of the Lumber River. The pit is 0.9 miles southeast of the junction of U. S. Highway 74 and N. C. Highway 211. Here the Duplin is a yellowish sandy marl with only a few macrofossils. It is overlain by unfossiliferous sands, but its base was not observed.

This paper does not include descriptions of all the Ostracoda found at these localities. Because some species are represented by so few individuals that their taxonomic relationships cannot be determined, they are omitted. Type specimens have been deposited in the U. S. National Museum. Illustrations, with the exception of figures 1 and 7, plate 85, and figures 1 and 3, plate 88, were drawn by the author.

The author wishes to thank Dr. J. W. Huddle of the Department of Geology, University of North Carolina, who gave counsel and valuable assistance, Dr. R. S. Bassler, who made available the types in the U. S. National Museum, Dr. H. V. Howe, who contributed of his time and wide knowledge and made available the extensive collection of Ostracoda at the University of Louisiana, and Dr. M. B. Stephenson for comment on the subgenus of *Cytheridea* (*Haplocytheridea*).

[1] This is a portion of a dissertation submitted to the Faculty of the University of North Carolina in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Geology.

SYSTEMATIC DESCRIPTIONS

Order OSTRACODA Latreille

Suborder PLATYCOPA Sars, 1865 (1866)

Family CYTHERELLIDAE Sars, 1865 (1866)

Genus CYTHERELLOIDEA Alexander, 1929

Cytherelloidea Alexander, C. I., Univ. of Texas

Bull. 2907, p. 55, 1929. Genotype *Cytherella williamsoniana* Jones, 1849, Monogr. Cret. Entom. Eng., Paleontogr. Soc., London, p. 31, pl. 7, fig. 26 a–i, 1849.

Carapace in side view subquadrangular or oblong-ovate. Anterior portion slightly compressed in dorsal view. Right valve a little larger than left which is slightly overlapped.

Surface ornamented by ridges, tubercles and pits, usually with low peripheral ridge.

Viewed interiorly valves moderately shallow, hinge structure simple, consisting of a groove along dorsal edge of right valve for reception of flange of left valve.

CYTHERELLOIDEA UMBONATA
Edwards, n. sp.
Plate 85, figures 1, 2

Carapace oblong, subquadrate; dorsal and ventral outlines slightly sinuate; anterior and posterior outlines broadly rounded; anterior margin bears about 25 short blunt denticles. Viewed externally, anterior margin formed by a low rounded ridge, which elsewhere becomes a flattened border. A small circular depression is conspicuous just above center of valves. Immediately before it a ridge, of variable prominence extends diagonally to dorsal margin. A narrow well defined ridge beginning just inside the anteroventral angle extends backward to posterior region and ends in a rather strong node. Another short ridge just behind the central depression ends in a strong node at posterior margin. Posterior nodes connected by a low ridge. Surface between ridges marked by irregular reticulations.

Interior of valves shallow. Hinge consists of groove in right valve, flange on left. No muscle scars observed.

Length of mature individuals, 0.64–0.75 mm., holotype 0.74 mm.; height 0.37–0.43 mm., holotype 0.43 mm.

This species is distinguished from *Cytherelloidea leonensis* Howe, 1934, by its reticulated surface and by the placement of the ridges, and from *Cytherelloidea denticulata* (Bosquet) by its more evenly rounded posterior.

Miocene, Duplin. Common in the upper part of the Duplin marl at Natural Well near Magnolia, N. C. Holotype, U. S. National Museum 559409.

Suborder PODOCOPA Sars, 1865 (1866)
Family BAIRDIIDAE Sars, 1887
Subfamily BAIRDIINAE Sars, 1923
Genus BAIRDIA M'Coy, 1844

Bairdia M'Coy, Synopsis, Char. Carb. Fossils, Ireland, p. 164, 1844: see also Kellett, Betty, Jour. Paleontology, vol. 8, pp. 120–138, 1934. Genotype, *Bairdia curta* M'Coy.

Carapace in side view subtriangular or rhomboidal, highest near middle; anterior outline rounded to angular, posterior usually acuminate. Left valve larger than right, overlapping it slightly and somewhat discontinuously with region of marked overlap just anterior to middle in ventral region where left valve is produced in liplike extension with corresponding indentation in right valve. Surface smooth or finely punctate, ornamented only by denticles along antero- or posteroventral margins.

Viewed interiorly valves moderately deep. Hinge structure simple, consisting of groove in left valve which receives edge of right valve. Frequently a faint groove occurs in right valve which receives ridge formed by edge of groove in left valve. These structures generally confined to straight dorsal portions of valves, variable in strength and extent.

Marginal area moderately broad, radial pore canals closely spaced, numerous, line of concrescence short distance within inner margin. Muscle scar area consists of circular group of variably shaped individual scars located nearly in center of shell.

BAIRDIA LAEVICULA Edwards, n. sp.
Plate 85, figures 3, 4

Complete carapace elongate-ovate in side view. Dorsal outline strongly arched; highest just anterior to middle. Anterior obliquely rounded; venter slightly concave; posterior bluntly pointed. Viewed dorsally moderately convex with slight flattening in middle third of outline. Left valve larger, overlaps right most conspicuously in middle third of ventral margin. Because it is larger, outline of left valve determines outline of complete carapace. Right valve subtrapezoidal; anterior dorsal margin straight, forms distinct angle with straight dorsal outline; anteroventral margin obliquely rounded; venter sinuous with well-marked convexity just anterior to middle; posterior produced in beaklike process.

Surface covered with minute, irregularly spaced punctae. Very short denticles may occur on ventral portion of posterior and anterior margins.

Hinge simple, consisting of groove in left valve which receives sharp edge of right valve. Marginal areas moderately wide; no radial pore canals observed. Muscle scar area near middle of valves, consists of about 8 to 10 irregularly rounded individual scars grouped in vertically elongated area.

Length of mature individuals, 0.71–0.81 mm., holotype 0.81 mm.; height 0.42–0.48 mm., holotype 0.46 mm.

This species may be distinguished from *B. subdeltoidea* (Münster), 1835, by its nearly straight ventral outline and its less convex dorsal outline.

Holotype from upper part of Duplin marl bed at Natural Well near Magnolia, N. C. Species common at locality 1, 2, rare at 3. Holotype, U. S. National Museum, 559410.

Genus BAIRDOPPILATA Coryell, Sample and Jennings, 1935

Bairdoppilata Coryell, Sample and Jennings, American Museum Novitates 777, p. 2, 1935. Genotype, *Bairdoppilata martyni* Coryell, Sample and Jennings, 1935, ibid., p. 3, figs. 1, 2, 1935.

Carapace bairdiaoid in side view. Left valve larger than right with greatest overlap in dorsal and midventral regions. Surface smooth or finely punctate. Short denticles or narrow frill may occur along ventral edge of valves.

Valves moderately deep interiorly. Hinge structure in middorsal region consists of groove in left valve and ridge on right valve extending about halfway down lateral slopes of dorsal edge. Presence of series of transverse taxodont-like teeth and sockets dorsal to terminal angulation of left valve is diagnostic feature. Similar teeth and sockets on edge of right valve.

Marginal areas moderately broad. Muscle scars of one species in circular group just below center of valve.

BAIRDOPPILATA TRIANGULATA Edwards, n. sp. Plate 85, figures 5–7

Carapace subtriangular in side view, right and left valves very dissimilar. Right valve subtrapezoidal, posterior margin produced in subacute beak like extension. Left valve larger, subtriangular, overlaps right valve most prominently in middle portion of ventral margin, dorsal margin strongly arched, posterior more pointed than anterior, greatest height at middle. Viewed dorsally carapace thickest in middle, tapering evenly to both ends. Surface smooth except for numerous minute punctae and a low swelling in middle of each valve. Short serrate denticulations frequent on anterior and posterior ventral margins.

Hinge of left valve consists of groove along inrolled surface of dorsal margin just posterior to highest point of valve. Groove continues on under side of dorsal edge but disappears within half of total length of anterior and posterior dorsal slopes. Teeth and sockets taxodontoid 6 or 7 at each end of hinge line just dorsal to anterior and posterior angulations and underneath overlapping portion of valve. Corresponding ridge with faint groove along its dorsal edge present on dorsal margin of right valve. Left dorsal edge of this valve fits into groove of dorsal slope, bears at each end of this slope taxodontoid teeth fitting into those of other valve. Muscle scars ten, irregularly rounded, in circular group just below center of valve, two more located below and behind this group and a few others located above and before primary area.

Two forms, one higher than the other; may represent the sexes, possibly the higher is female.

Length of mature individuals, 0.72–0.83 mm., holotype 0.81 mm.; height 0.48–0.52 mm., holotype 0.49 mm.

This species is distinguished from *B. taxodonta*, Howe and Law, 1936, by its straight posterodorsal slope.

Holotype from upper part of Duplin marl at Natural Well, N. C. Species common at all localities. Holotype, U. S. National Museum 559411.

Family CYTHERIDAE Baird, 1850
Subfamily CYTHERIDEINAE Sars, 1925
Genus CYTHERIDEA Bosquet, 1852
Subgenus HAPLOCYTHERIDEA Stephenson, 1936

Cytheridea (*Haplocytheridea*) Stephenson, 1936, Jour. Paleontology, vol. 10, p. 700. Genotype *Cytheridea montgomeryensis* Howe and Cham-

bers, 1935. Louisiana Dept. Conserv., Geol. Bull. 5, p. 17, pl. 1, fig. 1; pl. 2, figs. 1–3, 7, 9; pl. 6, figs. 17, 18.

Carapace elongate-ovate in side view, highest just anterior to middle. Left valve larger than right, overlapping it around entire margin. The anterior broadly to obliquely rounded, dorsum straight to slightly convex. Posterior obliquely rounded, posterior ventral angle usually nearly a right angle, venter nearly straight.

Surface usually coarsely, irregularly punctate. Anteroventral margins of valves usually bear about six short spines.

Viewed interiorly valves moderately deep, smooth. Hinge of right valve composed of two terminal, elongate, taxodont dental areas. Between these, but separated from dorsal edge by faint groove, is line of equidimensional minute crenulations. In left valve corresponding terminal notched sockets occur connected by faint narrow crenulated groove lying just beneath edge of dorsal margin.

Marginal area moderately broad with line of concrescence coinciding with inner margin except for a short distance at anterior end. Radial pore-canals numerous, slightly sinuate, closely but irregularly spaced. Muscle scar pattern consists of vertical row of four individual scars.

CYTHERIDEA (HAPLOCYTHERIDEA) PROBOSCIDIALA Edwards, n. sp.
Plate 85, figures 8–11

Carapace elongate ovate in side view, highest at middle. Viewed dorsally, right valve larger, overlapping on all margins; thickest in middle, tapering evenly to both ends. In side view, right valve dorsal outline evenly convex, highest point at middle; anterior evenly rounded, merging gradually with dorsum. Venter slightly sinuous with slight concavity just anterior to middle; posterior broadly, evenly rounded, making nearly a right angle with ventral, an oblique angle with dorsal margins. Left valve similar in shape to right except in posteroventral region where marked local swelling of outline occurs.

Surface of valves bears evenly spaced pits usually coincident with normal pore-canals.

PLATE 85

FIGS. *1, 2—Cytherelloidea umbonata* Edwards, n. sp. *1*, Left valve exterior, holotype USNM 559409. *2*, Right valve interior, paratype ×35. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 506)

3, 4—Bairdia laevicula Edwards, n. sp. *3*, Complete carapace right valve view, holotype USNM 559410. *4*, Right valve interior, paratype ×35. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 506)

5–7—Bairdoppilata triangulata Edwards, n. sp. *5*, Right valve interior, paratype. *6*, Left valve interior, holotype USNM 559411. *7*, Complete carapace right valve view, paratype ×35. Duplin marl, pit on A. R. Chesnut farm near Kenansville, N. C. (p. 507)

8–11—Cytheridea (Haplocytheridea) proboscidiala Edwards, n. sp. *8*, Left valve exterior. *9*, Same interior, holotype USNM 559412. *10*, Right valve exterior. *11*, Same interior, paratype ×22. Duplin marl, pit near Lumberton, N. C. (p. 508)

12–15—Anomocytheridea curta Edwards, n. sp. *12*, Left valve exterior. *13*, Same interior, holotype USNM 559413. *14*, Right valve interior. *15*, Same exterior, paratype ×22. Duplin marl, pit near Lumberton, N. C. (p. 510)

16, 17—Anomocytheridea floridana (Howe and Hough) 1935. *16*, Right valve exterior. *17*, Same interior, homoeotype ×22. Duplin marl, near Lumberton, N. C. (p. 510)

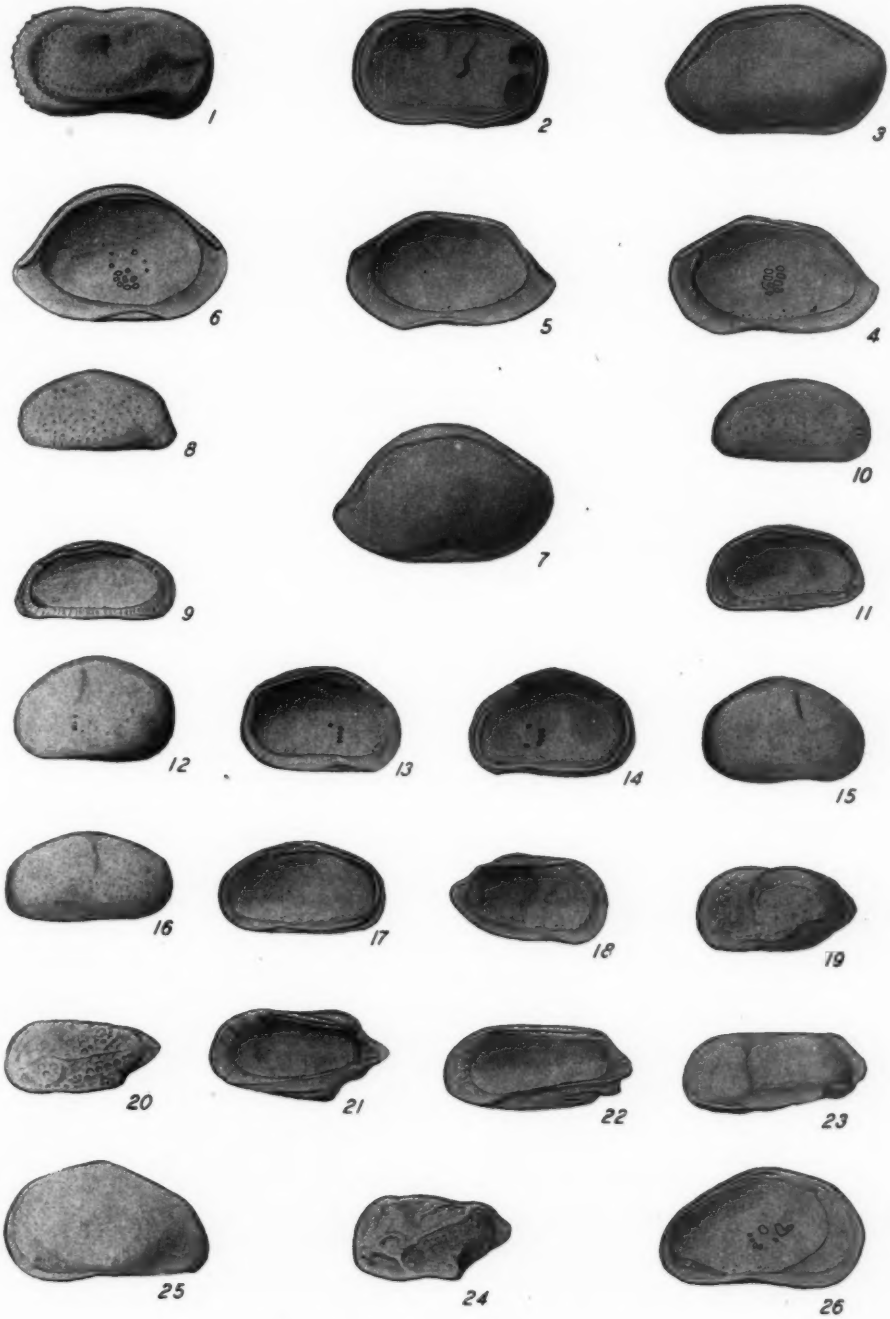
18, 19—Perissocytheridea subpyriforma Edwards, n. sp. *18*, Left valve interior. *19*, Same exterior, holotype ×35. USNM 559414. Duplin marl, pit near Lumberton, N. C. (p. 511)

20, 21—Paracytheridea altila Edwards, n. sp. *20*, Left valve exterior, holotype USNM 559415. *21*, Right valve interior, paratype ×35. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 512)

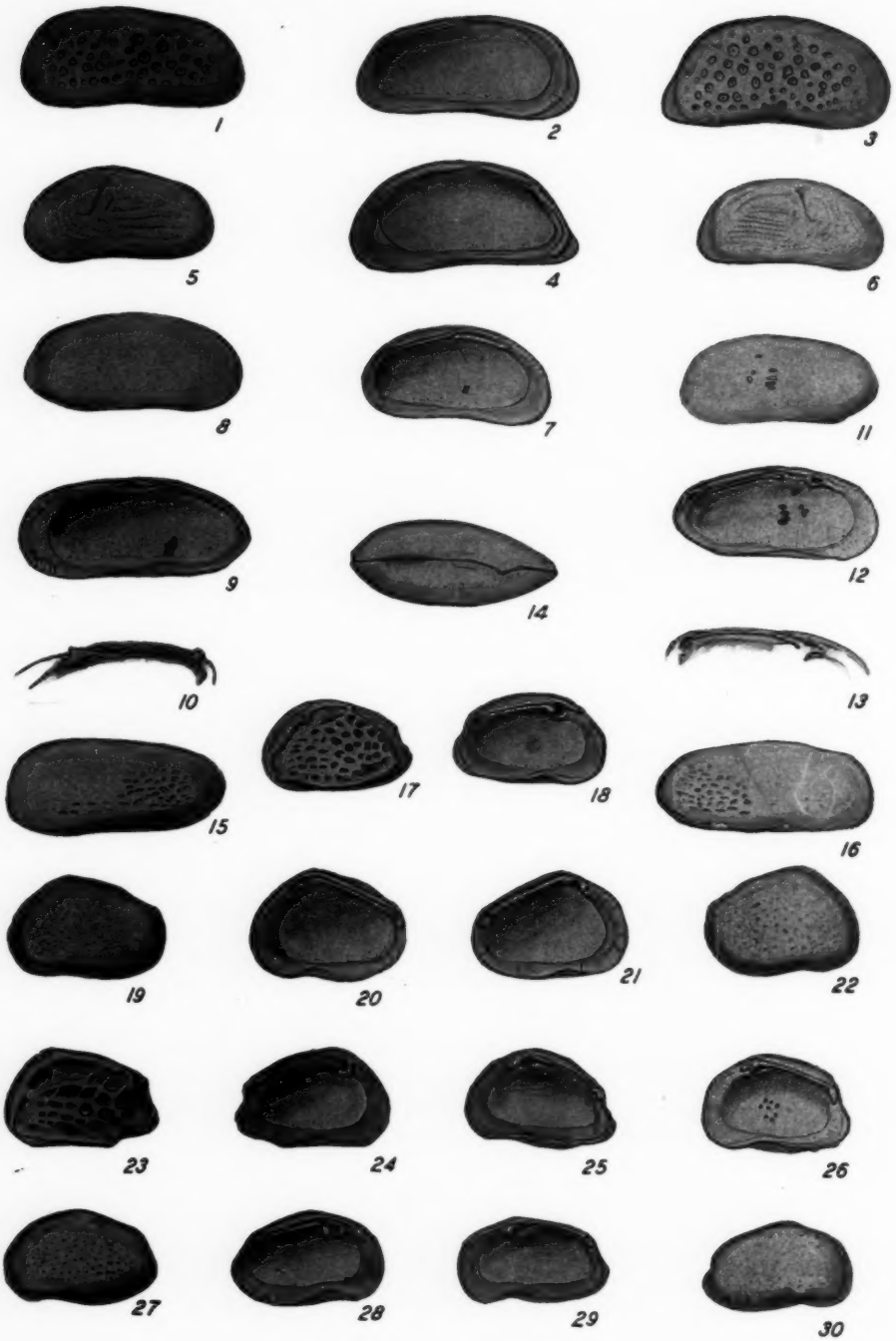
22, 23—Paracytheridea mucra Edwards, n. sp. *22*, Right valve interior, paratype. *23*, Left valve exterior, holotype ×35 USNM 559416. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 512)

24—Paracytheridea rugosa Edwards, n. sp. Right valve exterior, holotype ×35. USNM 559417. Duplin marl, pit near Lumberton, N. C. (p. 513)

25, 26—Eucythere gibba Edwards, n. sp. *25*, Left valve exterior. *26*, Same interior, holotype ×35. USNM 559418. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 513)



Edwards – Miocene Ostracoda



Edwards – Miocene Ostracoda

Right valve more convex than left, which is slightly compressed in posteroventral region where previously mentioned swelling is located.

Hinge unusual in that teeth are on left valve and sockets on right. Such reversal of dentition occurs in some other species (C. I. and C. W. Alexander, 1933, p. 280). No specimens of this species observed in which teeth were on right and sockets on left valve.

Hinge of right valve bears, just anterior to middle, an elongate cuspate area depressed below edge of valve which merges posteriorly into narrow, less depressed crenulated groove widening at posterocardinal angle into an elliptical cuspate area depressed and overhung by dorsal edge of valve. Posterior socket about one-third the length of anterior. Hinge of left valve consists of anterior elevated cuspate tooth with about twelve to fourteen individual elongate teeth, each with longitudinal groove on upper surface. This tooth merges posteriorly with lower, narrow ridge separated from border by a narrowed linear depression. Surface of this bar minutely crenulate, merging posteriorly with a higher cuspate tooth bearing four or five individual teeth similar to those of anterior.

Marginal area broadest anteriorly. Left valve with flattened flange along anterior and posterior margins. Line of concrescence coincides with inner margin throughout. Radial pore-canals more numerous anteriorly, slightly sinuate, closely but irregularly spaced. Muscle scar pattern consists of vertical group of four small elongate scars just anterior to middle.

Length of mature individuals, 0.85–0.96 mm., holotype 0.91 mm.; height 0.38–0.48 mm., holotype 0.44 mm.

This species differs from the genotype in being less pointed and lacking the curvilinear arrangement of surface pits. Specimens of this species were generically identified by M. B. Stephenson.

Holotype from Duplin marl near Lumberton, N. C. Species absent at loc. 1, rare at 2, and common at 3. Holotype, U. S. National Museum 559412.

Genus ANOMOCYTHERIDEA Stephenson, 1938

Anomocytheridea Stephenson, M. B., 1938, Jour

PLATE 86

FIGS. *1–4—Cytherideis ashermani* Ulrich and Bassler. *1*, Left valve exterior. *2*, Same interior homoeotype. *3*, Right valve exterior. *4*, Same interior, homoeotype ×35. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 514)

5–7—Cytherideis rugipustulosa Edwards, n. sp. *5*, Left valve exterior. *6*, Right valve exterior. *7*, Left valve interior, both valves same individual, holotype ×35. USNM 559419. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 514)

8–14—Campylocythere laeva Edwards, n. sp. *8*, Right valve exterior, female, paratype. Duplin marl, Natural Well, Magnolia, N. C. *9*, Right valve interior. *10*, Same tilted to show hinge, paratype. Duplin marl, pit near Lumberton, N. C. *11*, Left valve exterior, male. *12*, Same interior. *13*, Same tilted to show hinge, holotype. USNM 559420. *14*, Dorsal view of complete carapace, anterior to right, paratype. Duplin marl, Natural Well, Magnolia, N. C. All figures ×35. (p. 515)

15, 16—Campylocythere laeva posteropunctata Edwards, n. var. *15*, Left valve exterior. *16*, Right valve view of complete specimen, male, holotype ×35. USNM 559421. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 515)

17, 18—Hemicythere conradi Howe and McGuirt, 1935. *17*, Left valve exterior, homoeotype. *18*, Another left valve interior, homoeotype ×35. Duplin marl, Natural Well, Magnolia, N. C. (p. 518)

19–22—Cytheromorpha curta Edwards, n. sp. *19*, Left valve exterior. *20*, Right valve interior. *21*, Left valve interior. *22*, Right valve exterior. Single individual, holotype ×50. USNM 559422. Duplin marl, pit near Lumberton, N. C. (p. 516)

23–26—Hemicythere confragosa Edwards, n. sp. *23*, Left valve exterior. *24*, Same interior. *25*, Right valve interior, same individual, holotype. USNM 559423. *26*, Interior of another right valve, showing muscle scar area, paratype ×35. Duplin marl, pit near Lumberton N. C. (p. 518)

27–30—Hemicythere laevicula Edwards, n. sp. *27*, Left valve exterior. *28*, Same interior. *29*, Right valve interior. *30*, Same exterior, complete individual, holotype ×35. USNM 559424. Duplin marl, pit near Lumberton, N. C. (p. 518)

Paleontology, vol. 12, p. 141, 1938. Genotype *Cytheridea floridana* Howe and Hough, 1935. Florida Dept. Cons., Geol. Bull. 13, p. 10, pl. 2, figs. 15, 16, 18; pl. 4, figs. 6, 10.

Carapace ovate in side view. Anterior broadly, evenly rounded, posterior less broadly rounded. Left valve larger, overlaps right. Surface smooth or pitted with occasional faint sulci present.

Viewed interiorly valves moderately deep. Hinge structure of right valve consists of anterior transversely notched tooth located just in front of middle, faintly denticulate elongate socket and long narrow bar higher posteriorly bearing transverse notches which are less numerous than those of anterior dental area. Left valve with anterior notched socket, pronounced cuspate tooth and groove in which notches become more pronounced in posterior socketlike area.

Marginal areas moderately wide, bear numerous fairly straight radial pore-canals. Muscle scar pattern consists of vertical row of four elongate scars just anterior to middle of valve with two more anterior to top one, also three above and two below central group.

ANOMOCYTHERIDEA FLORIDANA
(Howe and Hough)
Plate 85, figures 16, 17

Cytheridea floridana Howe and Hough, 1935, Florida Dept. Cons., Geol. Bull. 13, pp. 10, 11, pl. 2, figs. 15, 16, 18; pl. 4, figs. 6, 10.
Anomocytheridea floridana (Howe and Hough), 1938, Jour. Paleontology, vol. 12, p. 142.

Carapace subovate, left valve larger than right; dorsum evenly, strongly arched; anterior broadly rounded; venter nearly straight; posterior rounded below, subtruncated above middle. Surface smooth except for widely spaced normal pore-canals and faint dorsally directed oblique sulcus just anterior to middle. Ventral portion of anterior margin usually bears several small, blunt spines.

Viewed interiorly valves moderately deep; inner margin moderately broad, but narrower at both ends. Edge of right valve bears flange which fits into groove of left valve. Hinge of right valve consists of an anterior, notched tooth bearing 12 to 15 denticulations, just in front of middle of valve followed by short depression which terminates posteriorly in thin, narrow bar stronger, slightly cuspate posteriorly. Bar enlarged sufficiently at posterior cardinal angle to be considered a definite tooth, bearing four or five rounded denticles. Hinge of left valve with anterior, long socket, oblique tooth-like projection, groove on dorsal margin and shallow crenulate socket at posterior cardinal angle.

Length of mature individuals in Duplin marl, 0.96–1.05 mm., homoeotype 0.96 mm.; height 0.42–0.51 mm., homoeotype 0.51 mm.

The only muscle scar pattern observed on these specimens consisted of a vertical row of four nearly circular scars with another U-shaped scar just anterior to the top one. The pattern, figured by Stephenson, shows more scars probably because of the state of preservation of his specimens which agree with the genotype in other respects. The radial pore-canals are nearly straight and very numerous at both ends.

Middle Miocene, *Arca* zone of Florida and Upper Miocene, Duplin marl of North Carolina. Rare at loc. 1 common at loc. 2.

ANOMOCYTHERIDEA CURTA Edwards, n. sp.
Plate 85, figures 12–15

In side view short carapace, ovate, highest in middle. Viewed dorsally, bluntly wedge-shaped, thickest posteriorly. Left valve slightly larger, overlaps right valve throughout; dorsum quite strongly arched, anterior obliquely rounded. Venter slightly concave in middle, posterior broadly rounded on left valve, less so on right. Surface smooth, except for dorsally directed oblique sulcus just anterior to middle, and irregularly spaced normal pore-canals.

Viewed interiorly valves moderately deep. Hinge of right valve consists of elongate, notched tooth, just anterior to the middle of valve, wider posteriorly with about 14 cusps followed by depression with two or three minor indentations in bottom and thin, delicate bar whose top bears small, rounded teeth. Bar widens posteriorly, ends abruptly in four or five separate, elongate taxodontoid teeth. Hinge of left valve consists of anterior, elongate, crenulate area depressed below edge of valve, terminated posteriorly by oblique raised area whose top

bears two or three minute crenulations. Behind this, inturned dorsal margin grooved for reception of bar on right valve. Groove expands posteriorly into depressed, crenulate socket at posterocardinal angle. Marginal area merges with interior and so appears to be very narrow. Radial pore-canals numerous, closely spaced, nearly straight. Muscle scar pattern consists of vertical row of four slightly elongated individual scars just anterior to middle and two others in front of top and bottom scars, respectively, of this row.

Length, 0.83–0.94 mm., holotype 0.92 mm.; height 0.49–0.59 mm., holotype 0.57 mm.

This species is distinguished from *Anomocytheridea floridana* (Howe and Hough, 1935), with which it might be confused, by being higher, shorter, and more massive.

Common in Duplin marl, near Lumberton, N. C. Holotype U. S. National Museum 559413.

Genus PERISSOCYTHERIDEA Stephenson, 1938

Perissocytheridea Stephenson, 1938, Jour. Paleontology, vol. 12, p. 145. Genotype, *Cytheridea ? matsoni* Stephenson, 1935, Louisiana Dept. Cons., Geol. Bull. 6, pp. 192–193, pl. 5, figs. 1, 2, 7, 8.

Carapace small, fragile, sybpyriform in side view highest just anterior to middle. Anterior is broadly rounded, dorsum nearly straight, moderately convex, venter quite convex. Dorsum and venter moderately converging posteriorly to rounded or somewhat pointed end. Surface ornamented by pits and ridges.

Viewed interiorly valves quite deep. Hinge structure of right valve consists of two terminal teeth at antero- and posterocardinal angles, both elongate, slightly raised, divided into cusps by transverse furrows, connected by a groove sharply depressed below edge of valve. Left valve with two terminal notched sockets separated by well-defined bar. Marginal area moderately broad, line of concrescence at inner margin except at anterior and posterior ends where it is displaced toward outer margin for distance of about half width of marginal area. Muscle scar area usually obscured by surface ornamentation.

Sexual dimorphism observed. Females tend to be more ovate, exhibit swelling in postero dorsal region.

PERISSOCYTHERIDEA SUBPYRIFORMA Edwards, n. sp.
Plate 85, figures 18, 19

Carapace subpyriform in side view. Anterior broadly to obliquely rounded. Dorsum straight, posterior half hidden by marked rounded swelling of posterior dorsal region. Venter nearly straight, converging quite sharply, posteriorly with dorsum. Posterior pointed with caudal process medially located. Very low swelling on surface, in anterior region separated from dominant flattened swelling of posterior region by sharp sulcus beginning at anterocardinal angle and continuing ventrally to middle of valve. Slightly raised, scalloped ridge extends from the anterocardinal angle around anterior end just inside margin, rises up on ventral ridge and disappears in posterior region. Dorsal portion of posterior lobe bears faint ribs merging anteriorly in ridge which dies out at sulcus. Surface with irregularly spaced, prominent, normal pore-canals.

Interior of shell deep with flattened middle portion. Hinge and marginal area characteristic of genus. Posteriorally inflated specimens probably females.

Length, 0.51–0.61 mm., holotype (female) 0.59 mm.; height 0.27–0.31 mm., holotype 0.30 mm.

This species is distinguished from *P. matsoni* (Stephenson), 1935, by its lack of a reticulate surface.

Holotype from Duplin marl near Lumberton, N. C. Rare at loc. 1, common at 2. Holotype, U. S. National Museum 559414.

Genus PARACYTHERIDEA Müller, 1894

Paracytheridea Müller, G. W. Fauna und Flora des Golfes von Neapel, Monographie 21, Berlin, p. 340 (pl. 26, figs. 16–26; pl. 29, figs. 4, 8), 1894. Genotype, *Paracytheridea depressus* Müller, 1894, ibid., p. 341, 1894.

The following description is compiled from the original German description and the plates and figures associated with it (Müller, 1894).

Carapace elongate, narrow posteriorly, usually alate. Viewed externally and laterally, a ventral swelling obscures ventral

edge. Posterior produced in caudal extension, usually about in middle.

Valves quite deep interiorly. Hinge of right valve consists of terminal teeth bearing three or four cusps at anterior and posterior cardinal angles, separated by a finely serrate groove. Hinge of right valve consists of anterior and posterior sockets separated by bar with finely serrate upper surface. Marginal area widest anteriorly and posteriorly, line of concrescence coinciding with inner edge. Radial pore-canals few in number, widely, but quite evenly spaced, occasionally bifurcating. Muscle scar pattern consists of four irregularly spaced and shaped individual scars subcentrally located.

PARACYTHERIDEA ALTILA Edwards, n. sp.
Plate 85, figures 20, 21

Carapace elongate, moderately alate; anterior outline obliquely rounded; posterior produced in marked caudal projection in both right and left valves; dorsal and ventral outlines nearly straight with marked posterior convergence. Surface ornamentation characterized by low swellings, reticulate pattern of ridges. Rounded node just in front of center separated from more or less bulbous swelling (which may or may not overhang posterodorsal margin) by curved-shallow depression beginning near anterodorsal angle, curving posteriorly up to middle of sharp ventral ridge, which bears low node at posterior end. A thin ridge begins near anterior ventral margin, bifurcates about one-third way up slope of anterior node; one part forms top of ventral ridge, other crosses anterior node, shallow depression and posterodorsal node, finally disappears in reticulation of posterior region. A low, glassy tubercle occupies anterodorsal angle.

Viewed interiorly valves deep, irregular. Hinge of right valve consists of nearly straight crenulated groove, with slightly curved, crenulate tooth at each end bearing about four crenulations. Left valve with slightly curved, crenulated socket at each end of very strong, crenulated ridge.

Marginal area fairly narrow except anteriorly and posteriorly where it is crossed by a few widely spaced straight pore-canals. Anterior portion of margin on right valve with slight lip line near outer edge. Both valves with slight flange on ventral margin just anterior to center. Degree of swelling of posterior dorsal node may indicate sexual differences. Holotype shows less swelling, probably indicative of male.

Length of mature individuals, 0.57–0.62 mm., holotype 0.59 mm.; height 0.25–0.31 mm., holotype 0.28 mm.

This form differs from *P. chipolensis* Howe and Stephenson, 1935, in its lack of a strong spine at the posterior end of the ventral ridge, the strength of its dorsal node and its slightly stronger medial depression.

Holotype from upper part of Duplin marl at Natural Well, Magnolia, N. C. Common to abundant at loc. 1, 3; rare at 2. Holotype, U. S. National Museum 559415.

PARACYTHERIDEA MUCRA Edwards, n. sp.
Plate 86, figures 22, 23

Carapace elongate; anterior broadly but obliquely rounded; dorsal outline straight, ventral outline sharply convergent with dorsum posteriorly, obscured by marked overhang of high ventral region; posterior region produced in marked caudal process. Carapace rises sharply from dorsal margin to high, sharp, ventral ridge which is deeply notched posteriorly. A low, anterior swelling present near ventral ridge, a larger swelling posterior to gentle, median sulcus. A low, rounded ridge extends from anterocardinal angle diagonally to about anteroventral angle. Surface with obscure reticulated pattern tending to pass into longitudinal ridges near ventral ridge. Ventral surface bears few, irregularly spaced, longitudinal carinae.

Interior deep; hinge is characteristic of genus, terminal teeth with four cusps. Radial pore-canals of anterior frequently paired, slightly curved, those on caudal projection bifurcate.

Length of mature individuals, 0.64–0.70 mm., holotype 0.68 mm.; height 0.24–0.31, holotype 0.27 mm.

This species differs from *P. altila* in its lack of strong reticulations. The sharp notch in the ventral ridge seems to be peculiar to this species.

Holotype from upper part of Duplin marl at Natural Well, Magnolia, N. C. Common at loc. 1 and 3. Holotype, U. S. National Museum 559416.

PARACYTHERIDEA RUGOSA Edwards, n. sp.
Plate 85, figure 24

Carapace in side view elongate, highly alate; anterior broadly rounded; dorsal outline straight; ventral margin obscured by strong, highly alate ventral region; when viewed interiorly margins converge sharply toward posterior, which is produced in marked caudal process. Surface ornamented by ridges. Dorsal ridge swings ventrally at anterocardinal angle, dies out on anterior slope. Ventral ridge begins at anteroventral angle, rises sharply to marked spine near posterior portion of ventral region. A third ridge extends posteriorly from just below middle of anterior margin, bifurcates short distance up anterior slope, one branch joining ventral ridge, other reaching posterocardinal angle. Behind bifurcation a low cross ridge forms triangular area just anterior to center. Posterior portion carries several less prominent ridges fanning out from triangle with a few cross ridges forming roughly reticulate pattern. A low spine is also present at base of high, alate spine of the ventroposterior border.

Hinge characteristic of genus; inner margin widest anteriorly; posterior portion bears a few widely spaced, nearly straight, radial pore-canals.

Length of mature individuals, 0.51–0.62 mm., holotype 0.58 mm.; height 0.23–0.34 mm., holotype 0.32 mm.

This species differs from those described above and from *P. clara* Coryell and Fields, 1937, in possessing sharp ridges and a triangular area anterior to the middle.

Duplin marl near Lumberton, N. C. Common. Holotype, U. S. National Museum 559417.

Genus EUCYTHERE Brady, 1866

Eucythere Brady, 1866, Linnean Soc. London Trans., vol. 26, p. 429. Genotype *Cythere declivis* Norman, 1865, Nat. Hist. Trans. Northumberland and Durham. vol. 1, p. 16, pl. 5, figs. 9–12. Also Alexander, C. I., 1934, Jour. Paleontology, vol. 8, p. 226; vol. 10, 1936, p. 689.

Carapace triangular in side view, highest anteriorly. Dorsal outline straight or nearly so, anterior broadly rounded, venter straight or slightly sinuate, posterior narrow, pointed or acutely rounded. Dorsal and ventral outlines strongly converging posteriorly. Surface usually smooth with a few widely spaced normal pore-canals.

Viewed interiorly valves moderately deep. Hinge structure weakly developed; right valve with narrow groove along dorsal margin and posterior low ridge like tooth; left valve with low obscure ridge separated from edge of shell by faint groove; socket-like depression at posterior end of bar may also occur. Other shell structures so easily recognized that determination of hinge structure generally not necessary for generic allocation. Marginal area broadest anteriorly, posteriorly. Line of concrescence coincides with inner margin in ventral region, is displaced outward until anteriorly it is about halfway between inner and outer margins; it is only slightly removed from inner margin posteriorly. Radial pore-canals widely spaced, straight. Muscle scar pattern consists of row of four elongate scars and anterior U-shaped scar with which one or two more small scars may be associated.

EUCYTHERE GIBBA Edwards, n. sp.
Plate 85, figures 25, 26

Carapace quite large, subpentagonal. Dorsal margin straight, less than half length of shell; anterior broadly rounded below, truncated above, more so in right valve. Ventral margin concave, greatest concavity just anterior to middle; posterior rounded below, slightly truncate above. Ventral swelling rounded, overhanging ventral margins slightly. Surface nearly smooth with very fine wrinkles anteriorly and a few, small, irregularly spaced normal pore-canals.

Hinge and marginal areas characteristic of genus. Muscle scar pattern medially located, consists of U-shaped anterior scar followed by two circular scars and four small circular posterior scars.

Length of mature individuals, 0.70–0.77 mm., holotype 0.75 mm.; height 0.38–0.40 mm., holotype 0.42 mm.

This species is distinguished from *E. chickasawhayensis* Howe, 1936, in being larger, less pointed posteriorly and showing two more muscle scars just behind anterior U-shaped scar.

Holotype from lower part of Duplin marl at Natural Well, Magnolia, N. C. Rare at

loc. 1 and 2. Holotype, U. S. National Museum 559418.

Genus CYTHERIDEIS Jones, 1856

Jones (1856, p. 46, 47) describes the genus as more or less triangular in outline. Surface smooth, pitted or tuberculate. Hinge simple with the dorsal margin of the left valve incurved under that of the right valve.

Cytherideis was originally classified as a subgenus of *Cythere*, but later it was raised to generic rank (Jones and Sherborn, 1889, p. 45). There is confusion concerning the synonymy so that any attempt to determine the exact limitations and characters of this genus can not be completed without access to the types of the early authors.

In assigning species to this genus, the generic characters recognized by Ulrich and Bassler (1904, pp. 126–129) and by Howe (1935, pp. 13–16) are accepted. These are apparently similar to those recognized by Jones as they include features which seem to be diagnostic of *C. trigonalis* Jones, 1856 the first species described under his subgenus.

CYTHERIDEIS ASHERMANI
Ulrich and Bassler
Plate 86, figures 1–4

Cytherideis ashermani Ulrich and Bassler, 1904, Maryland Geol. Survey Miocene, p. 126, pl. 37, figs. 10–16.
Cytherideis longula Ulrich and Bassler, idem, p. 138, pl. 37, figs. 21–27, 1904.
Cytherideis semicircularis Ulrich and Bassler, 1904, idem, p. 127, pl. 37, figs. 18–20, 1904.
Cytherideis ashermani Ulrich and Bassler, 1935, Florida Dept. Cons., Geol. Bull. 13, p. 14, pl. 3, figs. 8–10.

Carapace elongate. Left valve slightly larger than right, overlapping all around except posterior half of dorsal margin. Dorsal outline slightly arched; anterior obliquely concave, very nearly straight; posterior rounded on left valve, pointed on the right. Surface strongly, irregularly pitted.

Viewed interiorly valves moderately deep; marginal area narrow except anteriorly. Margin on right valve flanged except dorsally, fits into groove of left valve. Hinge of right valve an elongate, narrow groove on infolded dorsal edge, terminated at ends by flange. On left valve a corresponding ridge fits into groove of right. Radial pore-canals numerous, paired, slightly curved, irregularly spaced.

Length of mature specimens, 0.79–0.96 mm., homoeotype 0.83 mm.; height 0.35–0.40 mm., homoeotype 0.37 mm.

Miocene; Calvert of Virginia, *Arca* zone of Florida, Yorktown and Duplin of Virginia and North Carolina.

CYTHERIDEIS RUGIPUSTULOSA
Edwards, n. sp.
Plate 86, figures 5–7

Carapace elongage-ovate in side view. Dorsal outline slightly arched; anterior obliquely rounded; ventral outline concave in middle portion; posterior more obliquely rounded in right than left valve. Surface ornamented by low ridges, roughly conforming to outline of valves, arranged about point just above and anterior to middle of valves. On some specimens these ridges bear short, rounded pustules. A comma-shaped sulcus just posterior to anterocardinal angle disappears near middle of valve.

Hinge, radial pore-canals, and marginal area similar to those described for *C. ashermani* Ulrich and Bassler, 1904, from which this species may be distinguished by the presence of ridges and absence of pits.

Length of mature specimens, 0.62–0.70 mm., holotype 0.70 mm.; height 0.27–0.35 mm., holotype 0.33 mm.

Holotype upper part of Duplin marl at Natural Well, Magnolia, N. C. Common at all localities. Holotype, U. S. National Museum 559419.

Genus CAMPYLOCYTHERE Edwards, n. gen.

Carapace elongate, slightly arcuate in side view. Viewed dorsally, carapace somewhat wedge-shaped, thickest in middle or just posterior to middle; posterior border compressed. Dorsal edge infolded along posterior third of dorsal margin. Left valve slightly larger, overlaps right in anterocardinal region and along ventral border, just anterior to middle. Anterior usually evenly to obliquely rounded; dorsal outline straight to slightly arched; ventral outline slightly concave in middle, with little convergence with the dorsal outline posteriorly; posterior obliquely pointed to rounded. Surface may be smooth, punctate

or reticulate. Anteroventral margin may be slightly scalloped or denticulate.

Hinge of right valve elongate, narrow anterior tooth triangular in side view, highest anteriorly, followed by elongate socket, deepest posteriorly, but not as deep as anterior tooth is high. This socket opens partially to interior and merges posteriorly with finely serrated groove on edge of infolded dorsal margin; groove terminated posteriorly by ovate tooth, highest posteriorly, outwardly directed. Hinge of left valve, beginning just posterior to overlap, consists of socket, which is a depression in a thickened platelike process, deepest anteriorly, largely open to interior, terminated posteriorly by long, serrated bar on infolded dorsal edge whose anterior end is slightly raised to form low narrow tooth fitting into socket just behind anterior tooth of right valve; posterior socket ovate with upper two-thirds open to interior.

Marginal area broadest anteriorly and posteriorly. Line of concrescence removed from inner margin, usually nearer outer margin in middle of both ends, indented where the pore-canals are located. Radial pore-canals quite numerous, irregularly spaced, frequently not reaching outer edge.

Muscle scar pattern central, consists of vertical row of four closely spaced, irregularly elongate individual scars with two additional nearly circular scars before top scar of row and commonly four to six more scars in front of primary group which are those usually observed.

Sexual dimorphism occurs with female probably larger.

This genus differs from *Leptocythere* Sars, 1925, by being less quadrate and from *Cythereis* Jones, 1849, and *Leguminocythereis* Howe, 1936, by the triangular nature of the anterior tooth. Range; Miocene. Genotype, *Campylocythere laeva* Edwards, n. sp.

CAMPYLOCYTHERE LAEVA Edwards, n. sp.
Plate 86, figures 8–14

Carapace elongate, slightly arcuate; dorsal outline slightly arched, highest at middle; anterior obliquely rounded, ventral portion faintly and delicately scalloped; ventral outline slightly concave, with little convergence posteriorly toward dorsal outline; posterior bluntly pointed.

Surface characteristically smooth, with a few, irregularly spaced normal pore-canals. In posteroventral region slight swelling overhangs ventral margin behind which carapace is slightly flattened.

Hinge, inner margin, radial pore-canals, muscle scars characteristic of genus. Thicker and higher forms probably female.

Length of mature females, 0.77–0.83 mm.; males, 0.74–0.81 mm., holotype 0.74 mm.; height, females, 0.35–0.38 mm.; males 0.31–0.34 mm., holotype 0.33 mm.

Holotype from lower part of Duplin marl at Natural Well, Magnolia, N. C. Abundant at loc. 1., common at loc. 2 and 3. Holotype, U. S. National Museum 559420.

CAMPYLOCYTHERE LAEVA POSTEROPUNCTATA Edwards, n. var.
Plate 86, figures 15, 16

This variety differs from the typical form of the species in that its posterior half is finely to coarsely punctate. Such punctation is a persistent feature and seems to warrant varietal distinction. Sexual differentiation occurs.

Length of mature females, 0.75–0.81 mm.; males 0.74–0.81 mm., holotype (male) 0.79 mm.; height females, 0.37–0.40 mm.; males, 0.31–0.35 mm., holotype (male) 0.33 mm.

Holotype from upper part of Duplin marl at Natural Well, Magnolia, N. C. Also occurs at loc. 2. Holotype, U. S. National Museum 559421.

Genus CYTHEROMORPHA Hirschmann, 1909

Cytheromorpha Hirschmann, 1909, Beitrag zur Kenntnis der Ostracodenfauna des Finnischen Meerbusens. Helsingfors Medd. Soc. Fauna et Flora Fenn, 35, p. 290. Genotype, *Cythere fuscata* Brady, 1869: see also Alexander, C. I., 1934, Jour. Paleontology, vol. 8, p. 222.

Carapace oblong to ovate in side view, highest anteriorly. In dorsal view valves more or less compressed. Anterior broadly rounded, dorsal outline straight or slightly convex, ventral outline sinuous, posterior rounded. Dorsal and ventral outlines converge posteriorly in varying degree. Surface smooth, pitted or reticulate.

Viewed interiorly, valves shallow to moderately deep. Hinge structure well devel-

oped. Right valve with rounded tooth at the anterocardinal angle, surrounded by U-shaped furrow of variable depth, followed by shallow groove extending at posterocardinal angle, to two teeth joined in some species by curved thin ridge forming single broad U-shaped tooth. In left valve anterior U-shaped tooth fits around anterior tooth of right valve, followed by long thin bar and posterior tooth flanked by deep sockets connected by shallow furrow. Marginal area widest anteriorly. Line of concrescence closer to inner margin but anteriorly situated about halfway between outer and inner margins.

CYTHEROMORPHA CURTA
Edwards, n. sp.
Plate 86, figures 19–22

Carapace short, compressed, highest anteriorly; dorsal outline nearly straight, slightly convex; ventral outline nearly straight, but with marked concavity just anterior to middle, markedly converging posteriorly with dorsal outline; anterior broadly rounded below, truncated above; posterior broadly rounded below, obliquely rounded above middle. Surface covered with minute pits which may impart faint polygonal pattern to interior of valves and valves are translucent, appearing as underlying pattern. Border flattened and smooth except on dorsal margin.

Hinge of right valve consists of rounded anterior tooth on anterior margin just below anterocardinal angle, in middle of U-shaped depression with wider ends, terminated by a narrow groove entending posteriorly along dorsal margin to U-shaped tooth at posterior cardinal angle; closed end of latter tooth very thin, open ends bulbous. On left valve hinge consists of anterior U-shaped tooth fitting around corresponding tooth of right valve. A narrow bar along dorsal margin terminated posteriorly by U-shaped socket, in the middle of which is an oval tooth fitting into center of U-shaped tooth of right valve. Line of concrescence coincides with inner

---

EXPLANATION OF PLATE 87

FIGS. *1–3—Hemicythere minuta* Edwards, n. sp. *1*, Left valve exterior. *2*, Right valve exterior. *3*, Same interior, holotype ×35. USNM 559425. Duplin marl, pit near Lumberton, N. C. (p. 519)

4–11—Acuticythereis laevissima Edwards, n. sp. *4*, Right valve interior of immature molt, paratype. *5*, Left valve exterior. *6*, Same interior. *7*, Same tilted to show hinge. *8*, Right valve exterior. *9*, Same interior. *10*, Same tilted to show hinge; both valves of same individual, mature female, holotype USNM 559426. *11*, Dorsal view of complete carapace, anterior to right, paratype. All ×35. Duplin marl, pit near Lumberton, N. C. (p. 519)

12, 13—Acuticythereis laevissima punctata Edwards, n. var. *12*, Left valve exterior, male, holotype. USNM 559427. *13*, Right valve exterior, male, paratype ×35. Lower part of Duplin marl, Natural Well, Magnolia, N. C. (p. 520)

14–16—Acuticythereis multipunctata Edwards, n. sp. *14*, Left valve exterior. *15*, Right valve interior. *16*, Left valve interior; both valves of same individual, female, holotype ×35 USNM 559428. Duplin marl, pit near Lumberton, N. C. (p. 520)

17, 18—Acuticythereis multipunctata parva Edwards, n. var. *17*, Left valve exterior, holotype. USNM 559429. *18*, Right valve exterior, paratype ×35. Duplin marl, pit near Lumberton, N. C. (p. 520)

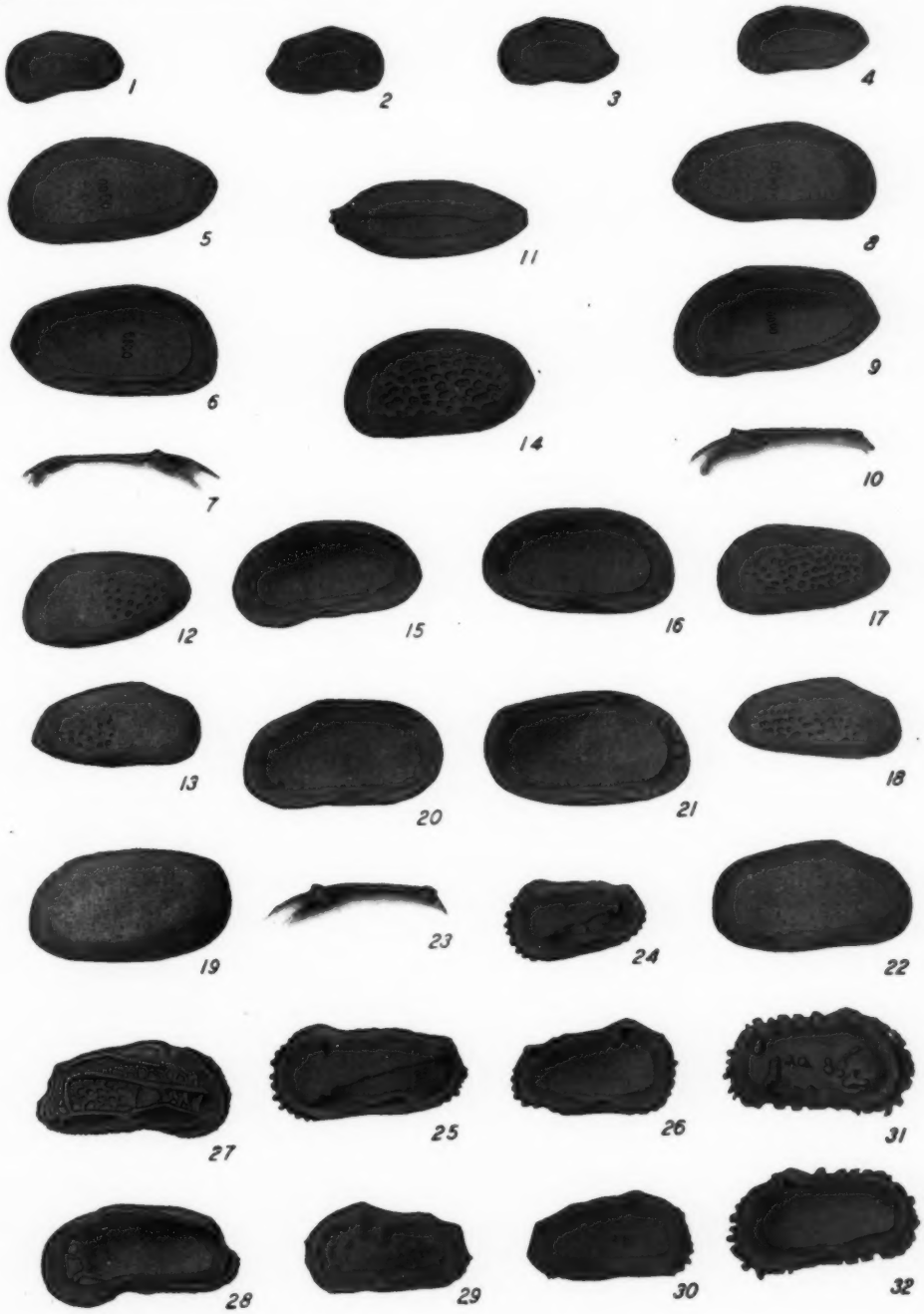
19–23—Basslerites giganticus Edwards, n. sp. *19*, Left valve exterior. *20*, Right valve interior. *21*, Left valve interior. *22*, Right valve exterior. *23*, Right valve tilted to show hinge, both valves of same individual, holotype ×35. USNM 559430. Duplin marl, pit near Lumberton, N. C. (p. 521)

24–26—Cythereis triplistriata Edwards, n. sp. *24*, Left valve exterior, male, paratype. *25*, Left valve exterior, female, holotype. USNM 559431. Lower part of Duplin marl, Natural Well, Magnolia, N. C. *26*, Interior of left valve, paratype ×35. Duplin marl, pit near Lumberton, N. C. (p. 522)

27, 28—Cythereis vaughani (Ulrich and Bassler). *27*, Right valve exterior. *28*, Same interior, showing peculiar scar common on well preserved specimens, homoeotype ×35. USNM Duplin marl, pit near Lumberton, N. C. (p. 522)

29, 30—Cythereis subimpressa Edwards, n. sp. *29*, Left valve exterior, holotype. USNM 559432. *30*, Left valve interior, paratype ×35. Duplin marl, pit near Lumberton, N. C. (p. 523)

31, 32—Cythereis exanthemata (Ulrich and Bassler) var. *gomillionensis* Howe and Ellis, 1935. *31*, Right valve exterior. *32*, Same interior, homoeotype ×35. Yorktown formation, 3–5 ft. above base of bed Z as exposed at Kings Mill Wharf, Va. (p. 521)



Edwards – Miocene Ostracoda

Edwards – Miocene Ostracoda

edge of margin except anteriorly where it occurs about midway on margin. Radial pore-canals quite evenly spaced, straight, not all reaching outer margin. No muscle scars observed.

Length of mature individuals, 0.38–0.44 mm., holotype (male) 0.40 mm.; height 0.27–0.33 mm., holotype 0.29 mm.

This species differs from the genotype by being much shorter. Females, indicated by posterior inflation, seem to be much in the minority as only occasional specimens have been found.

Holotype from Duplin marl near Lumberton, N. C. Common at this locality only. Holotype, U. S. National Museum 559422

Genus HEMICYTHERE Sars, 1925

Hemicythere Sars, 1925, An Account of the Crustacea of Norway, Ostracoda, vol. IX, Bergen, Bergen Museum, p. 182. Genotype, *Cythere villosa* Sars.

Sars (1925, p. 182) described the shell characters of this genus very briefly. He remarked on the solid consistency of the shell which resembles *Cythere* in shape. The valves are more or less unequal in size, with the surface pitted or roughly reticulated. To this should be added certain characteristics not mentioned by him, but which appear in the species which have been referred to this genus.

Carapace in outline usually somewhat almond-shaped with characteristic notch in posterodorsal area. Hinge of right valve usually consists of knob like, anterior tooth, broad postjacent socket changing behind to narrow groove terminated by ovate, outwardly directed tooth at posterocardinal angle. Left valve with anterior, deep, rounded socket, postjacent broad, blunt tooth joined to low, narrow bar, terminating at posterocardinal angle in elongate, oval socket mostly open to interior.

Marginal area broad with line of concrescence usually coinciding with inner margin. Radial pore-canals numerous, closely spaced, nearly straight.

Sars (1925, p. 182) proposed this genus to include a number of species referred to *Cy-*

EXPLANATION OF PLATE 88

FIGS. *1–4—Favella mesacostalis* Edwards, n. sp. *1*, Left valve exterior. *2*, Same interior, holotype. USNM 559433. *3*, Left valve exterior, immature molt. *4*, Same interior, paratype ×35. Duplin marl, pit near Lumberton, N. C. (p. 524)

5, 6—Favella rugipunctata (Ulrich and Bassler), 1904. *5*, Left valve exterior, homoeotype. *6*, Right valve interior, homoeotype ×35. Duplin marl, Natural Well, Magnolia, N. C. (p. 524)

7–10—Cytheretta reticulata Edwards, n. sp. *7*, Left valve exterior. *8*, Same interior, holotype. USNM 559434. *9*, Right valve exterior. *10*, Same interior, paratype ×22. Duplin marl, pit on A. R. Chesnut Farm near Kenansville, N. C. (p. 525)

11, 12—Cytherura wardensis Howe and Brown, 1935. *11*, Right valve exterior. *12*, Same interior, homoeotype ×48. Duplin marl, pit near Lumberton, N. C. (p. 525)

13–16—Cytherura reticulata Edwards, n. sp. *13*, Left valve exterior. *14*, Same interior, holotype USNM 559435. *15*, Right valve exterior. *16*, Same interior, paratype ×48. Duplin marl. pit near Lumberton, N. C. (p. 526)

17–20—Cytherura forulata Edwards, n. sp. *17*, Left valve exterior. *18*, Same interior, holotype. USNM 559436. *19*, Right valve exterior. *20*, Same interior, paratype ×48. Duplin marl, pit near Lumberton, N. C. (p. 526)

21–25—Cytherura elongata Edwards, n. sp. *21*, Left valve exterior, male. *22*, Same interior, holotype. USNM 559437. Fig. 23. Right valve exterior, male. *24*, Same interior, paratype. *25*, Right valve exterior, female, paratype ×48. Duplin marl, pit near Lumberton, N. C. (p. 526)

26, 27—Loxoconcha reticularis Edwards, n. sp. *26*, Left valve exterior, female. *27*, Same interior, holotype ×48. USNM 559438. Duplin marl, pit near Lumberton, N. C. (p. 527)

28–32—Loxoconcha subrhomboidea Edwards, n. sp. *28*, Right valve exterior, female, paratype. *29*, Left valve exterior, male. *30*, Same interior, holotype. USNM 559439. *31*, Right valve exterior. *32*, Same interior, paratype ×50. Upper part of Duplin marl, Natural Well, Magnolia, N. C. (p. 527)

33–35—Pellucistoma magniventra Edwards, n. sp. *33*, Left valve interior. *34*, Same exterior, holotype. USNM 559440. *35*, Right valve interior, paratype ×35. Duplin marl, pit near Lumberton, N. C. (p. 528)

thereis, and placed it in an intermediate position between that genus and *Cythere*. Blake (1933, p. 238) contended that this genus, as recognized by Sars, should be reduced to the rank of subgenus. The writer follows Sars and Howe (1935, p. 27) in giving it generic rank.

HEMICYTHERE CONRADI Howe and McGuirt
Plate 86, figures 17, 18

Hemicythere conradi Howe and McGuirt, 1935, Florida Dept. Cons., Geol. Bull. 13, p. 27, pl.3 figs. 31–34; pl. 4, fig. 17.

Carapace small, subovate in side view. Dorsal outline moderately arched; anterior broadly rounded below, obliquely rounded above middle; ventral outline slightly concave just anterior to middle, showing marked posterior convergence with the dorsal outline; posterior rounded below, concave above somewhat pointed middle portion. Surface ornamented by reticulated pattern of rounded ridges separating elongate, rounded pits. Margins bear low rounded rim.

Viewed interiorly valves moderately deep. Hinge characteristic of genus. Inner margin moderately broad, line of concrescence coinciding with inner edge except anteriorly where it is slightly removed. Muscle scar area consists of circular group of about eleven individual small scars, just anterior to middle.

Length of mature individuals, 0.31–0.57 mm., homoeotype 0.55 mm.; height 0.22–0.37 mm., homoeotype 0.33 mm.

Miocene, Chipola to Choctawhatchee of Fla., and all localities of the Duplin marl of N. C.

HEMICYTHERE CONFRAGOSA Edwards, n. sp.
Plate 86, figures 23–26

Carapace small, thickest just posterior to middle; anterior obliquely rounded; dorsal outline nearly straight; posterior concave above, slightly produced below middle; ventral outline of left valve nearly straight, of right valve slightly sinuous; and dorsal ventral outlines converge slightly toward posterior. Surface strongly ornamented. Beginning at anteroventral angle, a thin ridge extends along anterior and dorsal margins becoming stronger posteriorly where it ends in low, angular, blunt process. Ridge bears glassy tubercle at anterodorsal angle. Low, ventral ridge also ends posteriorly in low, blunt process. Surface covered by network of sharp ridges separating irregular, elongate, deep depressions.

Hinge characteristic of the genus. Line of concrescence practically coincides with inner edge of marginal area which widens anteriorly, possesses numerous closely spaced radial pore-canals, some bifurcating. Muscle scar pattern, just anterior to middle, a roughly circular group of six rounded scars with seventh in center.

Length of mature individuals, 0.53–0.57 mm., holotype 0.54 mm.; height 0.33–0.38 mm., holotype 0.34 mm.

The ornamentation of this species is much stronger than that of *H. conradi*, from which it is easily distinguished. The immature molts are less coarsely ornamented and have narrower margins.

Holotype from Duplin marl near Lumberton, N. C. Common at this locality only.

Holotype, U. S. National Museum 559423

HEMICYTHERE LAEVICULA
Edwards, n. sp.
Plate 86, figures 27–30

Carapace small, somewhat elongate; dorsal outline of right valve straight, of left valve rather strongly convex; anterior obliquely rounded with marked anterocardinal angle on right valve, but more gradual mergence on left valve; ventral outlines convex except for sharp concavity about one-third distance from anterior; posterior of right valve concave above, rounded below middle, of left valve truncated above, rounded below. Surface with narrow, flat rim except along dorsal edge, covered with faint pits which become larger near margins, almost approaching a reticulated surface. A few faint ridges present parallel to ventral border on ventral surface.

Hinge, marginal area and radial pore-canals characteristic of genus.

Length of mature individuals, 0.50–0.59 mm., holotype 0.57 mm.; height 0.29–0.35 mm., holotype 0.33 mm.

This species differs from *H. conradi* in its less strong ornamentation (it is not the young of that species) and from *Cythere trigonula* Jones, 1856, in its lack of ventral swelling.

Holotype from Duplin marl near Lumberton, N. C. Common.

Holotype, U. S. National Museum 559-424.

HEMICYTHERE MINUTA Edwards, n. sp.
Plate 87, figures 1–3

Carapace small, compressed. Dorsal margin slightly arched, more so in right valve; anterior somewhat obliquely rounded; ventral margin sinuous with concavity just anterior to middle; posterior of right valve rounded ventrally, concave dorsally, of left valve bluntly rounded below, concave above middle; right valve more pointed, more concave; marked convergence of dorsal and ventral margins posteriorly. Surface ornamented by low raised rim, beginning at the anterocardinal angle, following anterior and ventral margins to the posterior ventral angle where it makes nearly a right angle bend, continues up to posterocardinal region and follows dorsal margin to about middle of shell, gradually disappearing.

Hinge and radial pore-canal seem to be characteristic of genus. This species bears a suggestion of the peculiar trilobate scar in the anterior portion. More details of this structure are discussed in the description of *Cythereis vaughani* (Ulrich and Bassler), 1904.

Length of mature individuals, 0.42–0.48 mm., holotype 0.44 mm.; height 0.22–0.26 mm., holotype 0.24 mm.

This species differs from *H. laevicula* by the presence of ribs and lack of pits, and from *H. dalli* Howe and Brown, 1935, in being much smaller, and from *H. dalli* var. *redbayensis* Howe and Brown, 1935, in not possessing longitudinal ribs.

Duplin marl near Lumberton, N. C. Rare.

Holotype, U. S. National Museum 559-425.

Genus ACUTICYTHEREIS Edwards, n. gen.

Carapace ovate, posteriorly narrowed. Left valve slightly larger, overlapping right at anterocardinal angle and ventrally just anterior to middle; wedge-shaped in dorsal view, thickest just above middle; posterior region compressed at margin. In side view, anterior end obliquely rounded; dorsal outline straight or very slightly arched; ventral margin concave with greatest concavity just anterior to middle; marked convergence of dorsal and ventral outlines posteriorly. Posterior of right valve usually obtusely pointed, left valve obtusely rounded. Surface smooth, punctate or coarsely pitted.

Hinge of right valve consists of anterior roughly pyramidal tooth just below anterocardinal angle, followed by rounded elongate socket opening posteriorly into finely serrate groove on edge of infolded dorsal margin, extending to elongate, rounded, faintly lobate, outwardly directed tooth at posterocardinal angle. Left valve with anterior socket mostly open to interior, elongate, somewhat pointed, small tooth merging into long, finely serrate bar on rolled dorsal edge, extending to posterior, elongate, oval socket largely open to interior at posterocardinal angle.

Marginal area widest anteriorly and posteriorly. Line of concrescence removed from inner margin. Radial pore-canals more numerous anteriorly where two or three frequently have common origin in an indentation of line of concrescence, diverging toward margin, some emerging on exterior before they reach margin, in posterior marginal zone usually simple, nearly straight.

Most specimens well preserved, but few show muscle scar area; where observed, it consists of vertical row of four elongate scars with two more in front of top two scars of row, occasionally others present above primary area.

Sexual dimorphism occurs; males probably more elongate.

This genus differs from *Campylocythere* by more blunt anterior tooth on right valve, more pronounced postjacent socket, and of greater posterior convergence of dorsal and ventral outlines. It differs from *Pyricythereis* Howe, 1936, by lacking ribs on the anterior area and in the character of its radial pore-canals.

This genus is recognizable by its hinge and peculiar anterior radial pore-canals.

Range, Miocene. Genotype, *Acuticythereis laevissima*, n. sp.

ACUTICYTHEREIS LAEVISSIMA
Edwards, n. sp.
Plate 87, figures 4–11

Carapace ovate to pyriform in side view, posterior pointed, dorsal outline straight,

anterior obliquely rounded, ventral outline concave just anterior to middle. Posterior of right valve pointed, left more rounded. Surface smooth, but marked by irregularly spaced, normal pore-canals.

Hinge, marginal area and radial pore-canals characteristic of genus but in immature molts, radial pore-canals not grouped nor do they indent line of concrescence.

Length of mature individuals, 0.70–0.77 mm., holotype 0.77 mm.; height 0.31–0.38 mm., holotype 0.38 mm.

Holotype from Duplin marl near Lumberton, N. C. Common at all localities.

Holotype, U. S. National Museum 559-426.

Acuticythereis laevissima punctata Edwards, n. var.
Plate 87, figures 12, 13

Typical specimens of *Acuticythereis laevissima* are commonly associated with others which bear rounded punctae on the posterior half which seem worthy of recognition as a variety.

Length of mature individuals, 0.63–0.74 mm., holotype 0.65 mm.; height 0.29–0.37 mm., holotype 0.31 mm.

Holotype from lower part of Duplin marl at Natural Well, Magnolia, N. C. Common at loc. 1 and 2.

Holotype, U. S. National Museum 559-427.

Acuticythereis multipunctata Edwards, n. sp.
Plate 87, figures 14–16

Carapace ovate. Dorsal outline slightly arched, but hinge line straight; anterior of right valve more obliquely rounded than that of left; ventral outline almost straight, with slight concavity just anterior to middle, slightly converging posteriorly with dorsum; posterior of right valve pointed, that of left more rounded.

Surface covered with irregularly rounded to angular ridges which outline rounded to irregular pits.

Hinge characteristic of genus, but slightly weaker than in genotype. Anterior tooth of left valve not so prominent. One specimen from Natural Well is reversed where normal hinge structure of right valve occurs in left. Other interior features characteristic of genus.

Length, 0.66–0.74 mm., holotype 0.72 mm.; height 0.35–0.39 mm., holotype 0.38 mm.

This species may be distinguished by its all-over surface ornamentation.

Holotype from Duplin marl near Lumberton, N. C. Common at all localities.

Holotype, U. S. National Museum 559-428.

Acuticythereis multipunctata parva Edwards, n. var.
Plate 87, figures 17, 18

Associated with typical examples of the foregoing are a few specimens in which the ventroanterior region is smooth. These forms are also usually a little more elongate, but otherwise are typical. They do not appear to be immature molts of *A. multipunctata* because they are not always associated with each other.

Length of mature individuals, 0.59–0.66 mm., holotype 0.64 mm.; height 0.29–0.32 mm., holotype 0.31 mm.

Holotype from Duplin marl near Lumberton, N. C. Rare, at this locality only.

Holotype, U. S. National Museum 559-429.

Genus Basslerites Howe, 1937

Basslerella Howe, 1935, Florida Geol. Survey Bull. 13, p. 30.

Basslerites Howe, 1937, in Coryell and Fields, 1937, Am. Mus. Novitates 956, p. 11. Genotype, *Basslerella miocenica* Howe, 1935.

Carapace elongate, ovate in side view; in dorsal view, bluntly wedge-shaped; left valve larger, overlapping, greatest overlap at posterodorsal angle and middle of ventral margin. Dorsal outline straight; anterior evenly rounded, ventral outline nearly straight, subparallel with dorsal; posterior rounded below, subtruncate above middle, angle between posterodorsal outline and dorsal outline nearly 90 degrees. Surface usually smooth.

Viewed interiorly valves shallow to moderately deep. Inner margin moderately broad, line of concrescence between inner and outer margins near anterior; radial pore-canals few, usually bent upward near outer margin. Hinge of right valve consists of high strong anterior tooth below depression in

anterodorsal slope; deep, oblique socket, merging into narrow groove, paralleling dorsal margin; posterior tooth at posterocardinal angle, high, dorsally directed, somewhat swollen distally. Hinge of left valve consists of deep, anterior socket with anterior end open to interior; narrow high tooth, separated from margin by parallel groove, inside which heavy bar widens anteriorly to form toothlike structure by downward and outward curving; terminated posteriorly by deep, ovate, oblique socket. Muscle scar pattern consists of vertical row of four elongate, individual scars, and a heart-shaped anterior scar.

BASSLERITES GIGANTICUS
Edwards, n. sp.
Plate 87, figures 19–23

Carapace elongate, ovate in side view. Dorsal outline nearly straight, very slightly arched; anterior evenly to obliquely rounded; ventral outline straight not converging posteriorly with dorsal outline; posterior broadly, evenly rounded, with faint truncation characteristic of genus. Surface smooth; normal pore-canals small, irregularly spaced. Shell material quite clear, very thick.

Hinge and marginal areas characteristic of genus. Radial pore-canals generally simple, but some specimens have two or three originating from common indentation in line of concrescence anteriorly, giving impression of bifurcation. Muscle scar pattern apparently characteristic of genus.

Two forms one much more elongated than the other, usually occur together and probably represent the sexes. Shorter individuals are figured.

Length of mature individuals, 0.74–0.81 mm., holotype 0.75 mm.; height 0.38–0.44 mm., holotype 0.40 mm.

This species is at least two to three times as large as *B. miocenicus* (Howe), 1935 and also differs in the character of its anterior pore-canals.

Holotype from Duplin marl near Lumberton, N. C. Rare at loc. 1 and abundant at loc. 3. Holotype, U. S. National Museum 559430.

Genus CYTHEREIS Jones, 1849

Cythereis Jones, T. R., 1849, Cretaceous Entomostraca of England: Paleont. Soc. London Mon., p. 19. Genotype unselected. Also Alexander, C. I., 1934, Jour. Paleontology, vol. 8, p. 218.

Carapace elongate, usually highest anteriorly. Left valve larger than right, overlapping at anterocardinal angle and middle of ventral margin. Dorsal outline nearly straight, frequently concave just posterior to anterocardinal angle; anterior rounded, usually denticulate; ventral outline straight or slightly sinuate, parallel to or converging slightly with dorsal outline, posteriorly; posterior strongly compressed, more or less triangular, denticulate.

Surface usually bears raised rim or ridge on periphery, remainder of carapace ornamented by ridges, spines, pits, elevated knobs. A strong, rounded swelling, commonly present just anterior to middle, may be obscured by ornamentation in some species or by winglike process in subgenus *Ptergocythereis* Blake, 1933.

Hinge of right valve consists of knoblike anterior tooth, postjacent socket, shallow furrow extending length of dorsal margin, rounded, knoblike posterior tooth at posterocardinal angle. On left valve hinge consists of deep anterior socket, postjacent tooth, distinct bar on dorsal edge, posterior socket. Marginal area moderately wide, is crossed by numerous radial pore-canals. Line of concrescence usually coincides with inner edge of inner margin, slightly displaced toward outer margin in ventral anterior region. Muscle scars usually not observable because of thickness of carapace, character of ornamentation; some specimens show vertical row of four, horizontally elongate scars, one or two others close by.

CYTHEREIS EXANTHEMATA GOMILLIONENSIS
Howe and Ellis
Plate 87, figures 31, 32

Cythereis exanthemata gomillionensis Howe and Ellis, 1935, Florida Dept. Cons., Geol. Bull. 13, p. 19, pl. 1, figs. 6–12; pl. 4, fig. 3.

Carapace elongate, subquadrate in side view. Dorsal outline straight; anterior obliquely rounded, margin bearing fringe of flattened spines; posterior less obliquely rounded, margin bearing double row of blunt, flattened spines; ventral outline slightly concave, converging slightly with dorsal posteriorly. Surface ornamented by

three rows of strong, coarse spines, number of which varies. One row parallels dorsal border, projects beyond it at posterior cardinal angle, makes right angle bend, continues halfway to venter. Middle row begins at central node, continues posteriorly to break of posterior slope, makes right angle bend, continues almost to ventral margin. Anterior part of carapace ornamented by V-shaped group of spines originating at central node. Ridge just inside anterior margin bears glassy tubercle at anterior cardinal angle, projects slightly beyond margin, above middle gives way to closely spaced, distally flattened spines, continuing to anteroventral angle. Row of small globules occurs on the right valve between dorsal row of spines and hinge. Hinge and inner margins characteristic of genus. Radial pore-canals numerous, closely spaced, frequently sinuous.

This variety is similar to *Cythereis exanthemata* (Ulrich and Bassler) var. *marylandica* Howe and Hough, 1935, but is easily distinguished from it by its smaller size, the presence of a group of blunt spines anterior to the middle row of spines, and a row of small, globular pustules between the dorsal row of spines and the margin on the right valve. This row of pustules easily distinguishes this variety from *Cythereis exanthemata* (Ulrich and Bassler), 1904.

Length of mature individuals, female, 0.70–0.77 mm.; male, 0.77–0.81 mm.; homoeotype (female) 0.74 mm.; height (female) 0.38–0.44 mm., (male) 0.36–0.40 mm., homoeotype (female) 0.40 mm.

Figured specimen from Yorktown Bed Z, three to five feet above base as exposed at Kings Mill Wharf, Va. This specimen is a fully mature individual with spines more irregular, stronger than on younger individuals. It was chosen because specimens from the Duplin are poorly preserved.

Arca zone, Yorktown formation in Duplin marl. Rare at loc. 1, 2 and 3.

CYTHEREIS VAUGHANI
(Ulrich and Bassler)
Plate 87, figures, 27, 28

Cythere vaughani Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 109, pl. 38, figs. 25–27.

Cythereis vaughani (Ulrich and Bassler), 1935, Florida Dept. Cons., Geol. Bull. 13, p. 25, pl. 3, figs. 24–25; pl. 4, fig. 13.

Cythereis vaughani (Ulrich and Bassler), 1937, Am. Mus. Novitates 956, p. 9, fig. 10*a*.

Carapace elongate. Anterior obliquely rounded; posterior rounded below, concave above middle; dorsal outline sinuate because of ornamentation; ventral outline nearly parallel. Anterior margin and posterior half of ventral margin finely, evenly denticulate. Viewed externally anterior bears thin raised marginal rim. Three or four longitudinal ridges and several transverse ridges form variable reticulate pattern; areas between ridges usually punctate. Glassy tubercle at anteriocardinal angle; less prominent tubercle raised just anterior to center, where two dominant longitudinal ridges converge.

Interiorly valves moderately deep with fairly broad, inner margins. Straight, closely spaced radial pore-canals numerous anteriorly, decrease in number posteriorly. Inner margin of right valve grooved to receive left valve. Hinge characteristic of genus. Some well-preserved specimens show three-lobed scar just inside anterior inner margin (see pl. 88, fig. 9). Similar scar also observed in *Hemicythere minuta*, probably represents the attachment of some of soft parts.

Length of mature individuals in the Duplin, 0.68–0.72 mm., homoeotype 0.72 mm.; height 0.33–0.37 mm., homoeotype 0.37 mm.

Chesapeake group of Virginia, Choctawhatchee of Florida, Yorktown, Duplin of Virginia and North Carolina, Gatun of Cativa, Panama, Caloosahatchee Pliocene of Florida.

CYTHEREIS TRIPLISTRIATA
Edwards, n. sp.
Plate 87, figures 24–26

Carapace elongate, compressed; anterior rounded; posterior rounded ventrally, very slightly concave dorsally; dorsal outline nearly straight; ventral outline slightly sinuate, concave in middle. Anterior marginal rim well defined, complete, posterior rim less pronounced, merging ventrally with border, with double row of short denticles on lower side and on margin. Surface ornamented by three distinct ridges. Dorsal ridge scalloped on inner margin, makes right angle bend just anterior to posterocardinal area, continues diagonally toward anteroventral region to anterior node where it bifurcates; one faint ridge continues nearly to antero-

dorsal angle the other much stronger, scalloped, continues to anteroventral region. Third ridge extends from ventral margin in front of posteroventral angle, to ventral area, turns abruptly, joins marginal rim at posteroventral angle. Surface otherwise generally smooth or slightly granular.

Hinge structure characteristic of genus. Marginal area widest anteriorly with line of concrescence just inside inner margin. Radial pore-canals not well preserved, give appearance of being paired anteriorly at denticles.

Length of mature individuals, female, 0.61–0.72 mm., males 0.51–0.55 mm., holotype 0.72 mm.; height, female, 0.29–0.37 mm., males 0.27–0.31 mm., holotype 0.37 mm.

This species differs from *Cythereis austinensis* Alexander, 1929, by lacking pits between ridges and possessing a distinct ventral ridge. Specimens from the Lumberton locality are shorter than those from Natural Well.

Holotype from lower part of Duplin marl at Natural Well, Magnolia, N. C. Common at loc. 1 and 2, abundant at loc. 3. Holotype, U. S. National Museum 559431.

CYTHEREIS SUBIMPRESSA Edwards, n. sp.
Plate 87, figures 29, 30

Carapace elongate; dorsal outline straight to irregular due to overhang of dorsal ridge, marked convex swelling at anterocardinal angle; anterior obliquely rounded; ventral outline nearly straight; posterior slightly concave above, rounded below middle. Lower two-thirds of anterior margin, anterior third of ventral margin, posterior third of ventral margin, and lower half of posterior margin denticulate. Surface ornamented by low, double anterior, single posterior rims. Inner anterior rim weaker, connected with outer rim by five short, low ridges. Dorsal ridge rounded, irregular, highest posteriorly where it bends back toward anterior, continues to low, rounded node on anterior swelling; somewhat variable, strong on some specimens, very weak on others. Surface bears irregularly placed and shaped, vertical-sided depressions.

Hinge characteristic of *Cythereis*. Interior of valve shallow, reflects surface irregularities. Marginal area broadest anteriorly, line of concrescence near outer margin. Radial pore-canals numerous, closely spaced, simple, frequently paired. Muscle scar pattern consists of vertical row of four individual scars, anterior U-shaped scar.

Length of mature individuals, 0.59–0.62 mm., holotype 0.61 mm.; height, 0.29–0.34 mm., holotype 0.33 mm.

This species differs from the preceding by possessing less pronounced ridges and an irregularly pitted surface, and from *C. austinensis* Alexander, 1929, which lacks ridges.

Holotype from Duplin marl near Lumberton, N. C. Rare at loc. 1 and 3.

Holotype, U. S. National Museum 559432.

Genus FAVELLA Coryell and Fields

Favella Coryell and Fields, 1937, Am. Mus. Novitates 956, p. 8. Genotype, *Favella puella* Coryell and Fields, 1937, idem, pp. 8, 10.

Carapace quadrate in side view. Anterior obliquely rounded; dorsal outlines nearly straight; ventral outline slightly sinuate, usually parallel to dorsal outlines; posterior broadly rounded below, concave above middle. Ventral portion of anterior and posterior margins denticulate or scalloped. Carapace evenly and moderately convex. Surface ornamented by ridges, knobs, anterior and posterior rims, subcentral node.

Marginal area moderately broad, line of concrescence almost coincides with inner edge. Radial pore-canals few, irregular, frequently paired at denticulations. Hinge of right valve of mature molts consists of small high anterior tooth, postjacent socket usually open to interior, merging with long, thin groove on dorsal margin, oblique, curved posterior tooth at posterocardinal angle. Right valve possesses small anterior socket, postjacent high tooth merging with bar on dorsal margin, oval socket which produces swelling at posterocardinal angle. Immature molts have *Archicythereis* (Howe and Law, 1936) type of hinge, consisting, in right valve, of delicate, cuspate terminal teeth separated by crenulate groove; in left, dorsal margin swollen at cardinal angles for reception of teeth of right valve, remainder of margin straight.

In the author's opinion, this genus was described originally on immature molts of *Cythereis rugipunctata gatunensis* Coryell

and Fields, 1937 with which *Favella puella* is synonymous.

This genus is easily distinguished from *Cythereis* by its general rectangular outline and rugose ornamentation. Known range: Miocene to recent.

FAVELLA MESACOSTALIS Edwards, n. sp.
Plate 88, figures 1–4

Carapace subquadrate in side view, highest at anterocardinal angle, thickest in region of central node. Anterior obliquely rounded; dorsal outline straight; ventral outline with slight concavity just posterior to anteroventral angle, otherwise very nearly straight; posterior broadly rounded below middle, sharply concave above. Anteroventral margin bears fine denticulations. Posteroventral margin bears four blunt spines. Surface ornamentation quite strong. Low, rounded anterior ridge begins at anterocardinal angle, disappears at anteroventral angle. A few sharp ridges along dorsal margin, and usually at right angles to it, do not reach midline of valve. Middle marked by ridge which begins just posterior to anterior ridge, bifurcates at node marking muscle attachment, becomes single again behind node, continues almost to line of geniculation of posterior slope where it joins, at right angles, transverse ridge extending nearly from dorsal to ventral margin. In ventral portion four or five nodes parallel ventral margin. Another ridge present only on anterior half of the shell below anterior node.

Hinge and marginal area characteristic of genus. Radial pore-canals of anterior margins slightly curved, frequently paired; those of posterior occasionally paired at denticles.

Immature molts show in miniature, but less completely, features of mature carapace.

Length of mature individuals 0.66–0.70 mm., holotype 0.68 mm.; height 0.31–0.37 mm., holotype 0.33 mm.

This species differs from *Favella rugipunctata* (Ulrich and Bassler), 1904, by its lack of cross ridges on the posterior end and from *Favella puella* Coryell and Fields, 1937, by the presence of a median ridge.

Holotype from Duplin marl near Lumberton, N. C. Common at loc. 3. Holotype, U. S. National Museum 559433.

FAVELLA RUGIPUNCTATA
(Ulrich and Bassler)
Plate 88, figures 5, 6

Cythere rugipunctata Ulrich and Bassler, 1904, Maryland Geol. Survey, Miocene, p. 118, pl. 38, figs. 16, 17.

Cythereis rugipunctata (Ulrich and Bassler) Howe, 1935, Florida Dept. Cons., Geol. Bull. 13, p. 23, pl. 1, figs. 18, 20–22; pl. 4, figs. 22, 23, 1935.

Carapace elongate, subrectangular. Anterior obliquely rounded; dorsal outline nearly straight; ventral outline slightly sinuate, subparallel; posterior rounded ventrally, concave above middle. Ventral portion of anterior margin bears four or five short denticles, ventroposterior margin with four long, prominent spines. Surface marked by anterior node, posterior swelling separated by arcuate depression, low ridge just inside anterior margin; anterior portion of carapace bears several low, irregular nodes and ridges; posterior bears series of four or five transverse, flat-topped ridges which break up ventrally into nodes.

Interiorly, valves moderately deep, possess hinge and marginal area characteristic of genus. Radial pore-canals more numerous anteriorly, posteriorly some appear to bifurcate.

Transverse ridges on posterior portion diagnostic of this species.

Length of mature individuals in the Duplin, 0.59–0.64 mm., homoeotype 0.62 mm.; height 0.28–0.34 mm.; homoeotype 0.38 mm.

Chesapeake group of Va., *Arca* zone and younger of Florida, Duplin marl at Natural Well, Magnolia, N. C.

Genus CYTHERETTA Müller, 1894

Cytheretta Müller, G. W., 1894, Fauna und Flora des Golfes von Neapel 21 Monographie, Berlin, p. 382. Genotype, *Cytheretta rubra* Müller, 1894, ibid, p. 382.

The following generic description has been compiled from the German description and the plates and figures published with it.

Carapace ovate, left valve slightly larger, overlapping right at cardinal angles and ventral edge just anterior to middle. Surface smooth, pitted, ribbed or reticulated.

Hinge structure of right valve consists of strong, pointed anterior tooth, highest anteriorly, oblique socket deeper anteriorly, becoming shallow posteriorly, passing into long groove terminated at posterocardinal

angle by elongate ovate tooth, highest posteriorly. Left valve bears deep rounded socket, long bar resembling a tooth, widest, highest anteriorly, middle portion narrower, serrate, posterior portion thicker, slightly higher, terminated abruptly by deep, oval posterior socket.

Marginal area broadest along anterior and ventral margins with characteristic S-shaped outline. Line of concrescence coincides with inner edge. Radial pore-canals numerous, closely spaced, sinuous, frequently crossing, occasionally thickened in middle. Muscle scar pattern consists of ventral row of four elongate scars centrally located and anterior heart-shaped scar.

CYTHERETTA RETICULATA Edwards, n. sp.
Plate 88, figures 7–10

Carapace subrectangular, quite tumid in side view. Height nearly same throughout. Outlines of valves quite different; left valve larger than right overlapping at anterior and posterior cardinal angles and at middle of ventral margin. In right valve, dorsal outline nearly straight; anterior broadly, evenly rounded with marked concavity at anterocardinal angle where left valve overlaps; ventral outline very slightly concave in middle, only slightly converging with dorsal outline posteriorly; posterior broadly rounded below, concave above middle. In left valve dorsal outline straight with sharp convex swelling at posterocardinal angle; venter slightly concave in middle with slight convergence posteriorly; posterior bluntly rounded with middle portion of margin bearing five to six round, short denticles. Surface ornamented by elongate, rectangular or triangular pits separated by flat-topped ridges, in middle of valve arranged in lateral rows, on anterior and posterior parts conforming generally to outline of valve; two ridges, more prominent than others, originate in anteroventral region, one extends diagonally toward posterocardinal angle, other roughly parallels ventral margin.

Hinge and S-shaped marginal area characteristic of genus. Radial pore-canals, muscle scars not observed.

Length of mature individuals, 0.98–1.12 mm., holotype 1.09 mm.; height 0.51–0.70 mm., holotype 0.55 mm.

This species differs from *Cytheretta karlana* Howe and Pyeatt, 1935, in being less pointed posteriorly and possessing stronger ornamentation.

Holotype from Duplin marl, A. R. Chesnut's Farm, 3 miles southwest of Kenansville, N. C. Rare at loc. 1 and common at 2 and 3. Holotype, U. S. National Museum 559434.

Subfamily CYTHERURINAE Müller, 1894
Genus CYTHERURA Sars, 1865 (1866)

Cytherura Sars, G. O., 1865, Oversigt af Norges marine Ostracoder, p. 69, Genotype *Cythere gibba* O. F. Müller, 1785. Entomostraca, p. 66, pl. 7, figs. 7–9. Also Alexander, C. I., 1936, Jour. Paleontology, vol. 10, pp. 690, 691.

Carapace small, elongate or subquadrate. Dorsal outline straight or slightly convex; anterior rounded; ventral outline sinuous, parallel or slightly converging with dorsal outline posteriorly; posterior produced in flattened obtuse caudal process. Surface smooth, reticulated or ridged.

Marginal area of varying width, usually very broad anteriorly and posteriorly, sometimes occupying greater portion of interior of shell. Line of concrescence quite irregular. Radial pore-canals long, simple, sinuous, slender and bulbous near outer ends. Hinge of right valve consists of groove in dorsal margin with tooth at each end below. Left valve with ridge whose ends are tooth like and apparently fit inside terminal teeth of right valve.

CYTHERURA WARDENSIS Howe and Brown
Plate 88, figures 11, 12

Cytherura wardensis Howe and Brown, 1935, Florida Dept. Cons., Geol. Bull. 13, p. 36, pl. 1, figs. 23, 27; pl. 4, fig. 19.

Carapace elongate subrectangular in side view, height about equal throughout, thickest posteriorly. Anterior rounded; dorsal outline nearly straight; ventral outline sinuate; posterior produced in short caudal process. Surface ornamented by fine reticulations, shallow longitudinal striae on flattened ventral surface. Ventral margin keeled posteriorly, so that, when two valves are together, there is distinct, sharp ridge in that region. Shallow sulcus present just in front of middle.

Hinge, inner margin, radial pore-canals characteristic of genus.

Length of mature individuals in the Dup-

lin 0.44–0.48 mm., homoeotype 0.46 mm.; height 0.22–0.26 mm., homeotype 0.24 mm.

Arca zone of Florida, Duplin marl of North Carolina. Rare at loc. 2, common at loc. 3.

CYTHERURA RETICULATA Edwards, n. sp.
Plate 88, figures 13–16

Carapace small, elongate, ovate in side view. Dorsal outline of right valve slightly arched; anterior evenly rounded, but with marked concavity near dorsal margin where left valve overlaps, depth of concavity varies slightly; ventral outline concave in middle; posterior with caudal processes characteristic of genus. Dorsal outline of left valve slightly arched, merging gradually with posterior; anterior obliquely rounded; ventral outline slightly concave in middle. Carapace slightly inflated in ventral region. Surface covered with reticulate pattern of ridges forming rectangular pits near margin, square pits in middle of valves. Anterior border, caudal process smooth.

Hinge characteristic of genus. Marginal area broadest anteriorly, of moderate width, crossed by few widely spaced, slightly irregular radial pore-canals.

Length of mature individuals, 0.38–0.42 mm., holotype 0.40 mm.; height 0.20–0.40 mm., holotype 0.22 mm.

This species differs from *Cytherura wardensis* Howe and Brown, 1935, by its more pointed posterior slopes and lack of posterior swelling.

Holotype from Duplin marl near Lumberton, N. C. Common at loc. 1 and 2, abundant at loc. 3. Holotype, U. S. National Museum 559435.

CYTHERURA FORULATA Edwards, n. sp.
Plate 88, figures 17–20

Carapace elongate, thickest in posterior region. Dorsal outline slightly arched; anterior obliquely rounded; posterior produced in very short caudal process; ventral margin slightly sinuate. Narrow keel on ventral margin makes posterior appear higher in side view. Surface ornamentation consists of low, longitudinal ribs converging anteriorly and posteriorly connected by faint, delicate cross ribs at irregular intervals.

Interior moderately deep, inner margin and hinge characteristic of genus. Muscle scar pattern consists of vertical row of four elongate, individual scars subcentrally located with two others anterior to topmost.

Length of mature individuals, 0.41–0.55 mm., holotype 0.41 mm.; height, 0.24–0.29 mm., holotype 0.27 mm.

The species differs from *C. reticulata* in its shorter caudal process and riblike ornamentation.

Holotype from Duplin marl near Lumberton, N. C. Common at loc. 1 and 3, rare at loc. 2. Holotype, U. S. National Museum 559436.

CYTHERURA ELONGATA Edwards, n. sp.
Plate 88, figures 21–25

Carapace elongate, subrectangular. Dorsal outline of right valve very slightly arched, of left valve straight; anterior broadly rounded below, obliquely rounded above; ventral outline straight, overhung by swelling of ventral region; posterior produced in caudal process. Surface ornamented by longitudinal ribs and delicate transverse ridges forming irregular, rectangular pattern. Anterior border smooth with a few irregularly placed, low ridges.

Hinge characteristic of genus. Marginal areas broadest anteriorly and posteriorly. Radial pore-canals long, curved, occasionally bifurcating but rarely crossing. Shorter and higher individuals, probably female.

Length of mature individuals, female, 0.63–0.71 mm.; male, 0.46–0.55 mm., holotype 0.70 mm.; height (female) 0.26–0.29 mm., (male) 0.22–0.25 mm., holotype 0.28 mm.

This species differs from *C. reticulata* in that its ornamentation is more linear, and its weaker cross ribs do produce a strong rectangular pattern. The nearly straight dorsal margin differentiates from *C. forulata*.

Holotype from Duplin marl near Lumberton, N. C. Rare at loc. 1 and common at loc. 2 and 3. Holotype, U. S. National Museum 559437.

Subfamily LOXOCONCHINAE Sars, 1926
Genus LOXOCONCHA Sars, 1865

Loxoconcha Sars, G. O., Oversigt af Norges marine Ostracoder, p. 61, 1865. Genotype, *Cythere impressa* Baird, 1850, Natural History of British Entomostraca, p. 175, pl. 21, fig. 9. See also Alexander, C. I., Jour. Paleontology,

vol. 8, pp. 227, 228, and vol. 10, 1936, p. 693, 1934.

Carapace rhomboidal to quadrate. Dorsal outline straight, occasionally slightly arched, with distinct anterior and posterior cardinal angles; anterior rounded; ventral outline straight or sinuate, curving upward posteriorly to blunt caudal process just above middle of posterior. Posteroventral margin usually keeled. Surface of valve pitted, reticulate or smooth, in most species glassy tubercle occurs near anterocardinal angle.

Marginal area moderately broad. Line of concrescence at moderate distance from inner margin anteriorly and posteriorly. Radial pore-canals moderately numerous, straight, simple.

In Cretaceous species the hinge of right valve consists of anterior socket, postjacent knoblike tooth, shallow furrow, posterior tooth; in left valve, it consists of anterior tooth; postjacent socket, narrow bar, long posterior socket, narrow anteriorly, widened posteriorly. In Tertiary species, teeth generally stronger, bar and groove commonly crenulated.

LOXOCONCHA RETICULARIS Edwards, n. sp.
Plate 88, figures 26, 27

Carapace subovate in side view. Dorsal outline nearly straight, very slightly concave just posterior to middle; ventral outline straight, converging slightly posteriorly; anterior broadly rounded below, obliquely rounded above middle; posterior obliquely rounded below, very slight caudal process above middle. Externally, flattened marginal border widest anteriorly and posteriorly, forms slight keel on dorsal margin. Surface reticulated concentrically about center of valves.

Hinge in right valve consists of elongate anterior socket deepest in anterior half, crenulate groove, double posterior tooth enclosing shallow socket, posterior part more elongate. Left valve with anterior tooth higher in front half, crenulate ridge, double posterior socket divided by low, rounded wall. Radial pore-canals, line of concrescence characteristic of genus.

Larger, more elongate specimens probably female.

Length of mature individuals, male, 0.44–0.48 mm., female 0.48–0.52 mm., holotype 0.48 mm.; height (male) 0.27–0.29 mm., (female) 0.27–0.29 mm., holotype 0.28 mm.

This species is closely related to *L. jacksoni* Howe and Chambers, 1935, but differs slightly in outline and strength of reticulations. It differs from *L. mornhinvegi* Howe and Chambers, 1935, in that its pits parallel to the dorsal margin are less oblique and those near the posterior are coarser.

Holotype from Duplin marl near Lumberton, N. C. Rare at loc. 1, common at loc. 2 and 3. Holotype, U. S. National Museum 559438.

LOXOCONCHA SUBRHOMBOIDEA Edwards, n. sp.
Plate 88, figures 28–32

Carapace subrhomboidal. Dorsal outline slightly arched; ventral outline sinuate, concave just anterior to middle; anterior rounded below, somewhat obliquely truncated above; posterior obliquely rounded, faint caudal process above center. Valves moderately convex, thickest in middle. Surface covered with minute pits and widely spaced, normal pore-canals, bears small, low, glassy tubercle at anterocardinal angle.

Interior of valves moderately deep, marginal area widest anteriorly and in posteroventral region. Line of concrescence at inner margin along midventral border, about halfway in, anteriorly and posteriorly. Anterior and posterior radial pore-canals few, evenly spaced, straight. Margin of right valve with small furrow for reception of sharp edge of left valve.

Muscle scar pattern consists of four elongate scars in ventral row with one elongate anterior scar.

Hinge of right valve consists of anterior double socket, in front of the cardinal angle, open to interior; serrate furrow, double posterior tooth with posterior part strong, elongate, anterior part weak, serrate. Left valve fitted with corresponding sockets, serrate bar, teeth.

Two forms recognized, the shorter is probably male.

Length of mature individuals, male, 0.47–0.51 mm., female 0.53–0.57 mm., holotype (male) 0.49 mm.; height (male) 0.27–0.31 mm., (female) 0.29–0.32 mm., holotype 0.31 mm.

This species differs from *L. howei* Murray, 1938, by being less pointed posteriorly and lacking the ridge on the central surface.

Holotype from upper part of Duplin marl at Natural Well, Magnolia, N. C. Common to abundant at loc. 1 and 2, rare at loc. 3. Holotype, U. S. National Museum 559439.

Subfamily PARADOXOSTOMINAE Müller, 1894
Genus PELLUCISTOMA Coryell and Fields, 1937

Pellucistoma Coryell, H. N. and Fields, Suzanne, 1937, Am. Mus. Novitates 956, p. 17. Genotype, *Pellucistoma howei* Coryell and Fields, 1937, idem, pp. 17, 18, figs. 18a, b, c.

Carapace small, subovate in side view; dorsal outline straight to slightly arched; anterior obliquely, broadly rounded; ventral outline sinuous; posterior produced in caudal process above center. Surface finely perforated.

Viewed interiorly valves moderately shallow. Hinge structure of right valve consists of faintly serrated groove with rude anterior socket formed by a tooth like projection at the anterocardinal angle, posterior end has a process which receives end of bar of left valve. The left valve bears a faintly serrated thin bar, slightly thickened anteriorly. Marginal area widest anteriorly. Line of concrescence quite irregular usually nearer outer margin at radial pore-canals, but lying near inner margin throughout remainder of its course in genotype.

Muscle scar pattern, in anterior half of valve consists of large round scar with posterior transverse, irregular line of oval scars, other irregular surrounding scars.

PELLUCISTOMA MAGNIVENTRA Edwards, n. sp.
Plate 88, figures 33–35

Carapace small, elongate. Dorsal outline short, slightly arched; anterior very obliquely rounded, merging gradually with dorsal outline; ventral outline convex posterior to middle; posterior obliquely rounded below, slightly concave above; characteristic caudal projection just above middle of valve. Surface smooth, finely perforated.

Hinge of right valve consists of poorly defined groove along dorsal margin with anterior tooth-like process projecting from inner margin, forming socket for reception of expanded end of bar on left valve and on posterior is a hooklike process which receives expanded posterior end of bar of left valve. Inner margin very broad around anterior and posterior ventral region, narrower elsewhere. Line of concrescence close to outer margin. Radial pore-canals widely spaced, frequently bifurcate.

Length of mature individuals, 0.61–0.64 mm., holotype 0.63 mm.; height 0.29–0.33 mm., holotype 0.33 mm.

This species differs from *P. howei* Coryell and Fields in that its anterior is more obliquely rounded, its dorsum is arched, its posterior is less pointed, and carapace as a whole seems more elongate.

Holotype from Duplin marl near Lumberton, N. C. Rare.

Holotype, U. S. National Museum 559440.

MANUSCRIPT RECEIVED FEBRUARY 22, 1943.

BIBLIOGRAPHY

ALEXANDER, C. I. and ALEXANDER, C. W., 1933, Reversal of valve size and hinge structure in a species of the genus *Cytheridea:* Am. Midland Naturalist, vol. 14, pp. 280–283, 4 figs.

BLAKE, C. H., 1933, New Crustacea from the Mount Desert region. Ostracoda: in; W. Procter, 1933, Biological Survey of the Mount Desert region, pt. 5, pp. 229–241.

HOWE, H. V. and LAW, JOHN, 1936, Louisiana Vicksburg Oligocene Ostracoda: Louisiana Dep. Cons. Geol. Bull. 7, pp. vii–96, 6 pls.

HOWE, H. V., et al, 1935, Ostracoda of the *Arca* zone of the Choctawhatchee Miocene of Florida: Florida Dept. Cons. Geol. Bull. 13 pp. 1–37, 4 pls.

JONES, T. H., 1856, A monograph of the Tertiary Entomostraca of England: Palaeontographical Soc., London, pp. 1–68.

JONES, T. H. and SHERBORN, C. D., 1889, A supplementary monograph of the Tertiary Entomostraca of England: Paleontographical Soc., London, 55 pp., 3 pls.

MACNEIL, F. STEARNS, 1938, Species and genera of Tertiary *Noetinae:* U. S. Geol. Survey Prof. Paper 189-a, pp. 1–49, 6 pls., 2 figs.

MANSFIELD, WENDELL C., 1936, Stratigraphic significance of Miocene, Pliocene, and Pleistocene *Pectinidae* in the southeastern United States: Jour. Paleontology, vol. 10, pp. 168–192, 1 text-fig., pls. 22–23.

MÜLLER, G. W., 1894, Fauna und Flora des Golfes von Neapel, 21 Monographie, Berlin, 404 pp., 13 figs., 40 pls.

SARS, G. O., 1925, An account of the Crustacea of Norway, vol. 9, Ostracoda, pts. 5–12, pp. 73–208, 64 pls., Bergen (Bergen Museum).

ULRICH, E. O., and BASSLER, R. S., 1904, Ostracoda. Maryland Geol. Survey, Miocene pp. 98–130, pls. 35–38.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 529–534, NOVEMBER, 1944

AULOPORIDAE AND HEDERELLOIDEA

(AND A SYSTEM TO AVOID AMBIGUOUS USE OF GENERIC NAMES)

MAXIM K. ELIAS
Nebraska Geological Survey, Lincoln

ABSTRACT—The morphology of the Aluoporidae is comparatively simple but much misunderstood and its taxonomy is complicated. The distinguishing characters of *Aulopora*, *Cladochonus* (= *Monilopora*), *Aulocaulis* and the externally similar bryozoan *Hederella* are summarized.

Confusion arises from the use of generic names for natural genera, form genera, "utilitarian" genera and composite genera. A system of prefixed symbols is proposed to distinguish the possible different usages of a single generic name.

INTRODUCTION

TABULATE corals of the family Auloporidae Nicholson, which are common in the American late Paleozoic rocks, have been reviewed and revised by several authors. Recently analytical comparison was extended to include fossil Bryozoa of the suborder Hederelloidea which resemble these corals. None of the published reviews, however, has sufficiently summarized the means by which these fossils may be classified in routine paleontological work. This review is intended to provide paleontologists with a convenient summary and references to the principal works on the subject, and also to analyze the complicated taxonomy of the discussed fossil genera.

HISTORICAL REVIEW

The following are the principal scientific contributions on the Auloporidae and Hederelloidea.

1. August Goldfuss (1826, p. 5) proposed the genus *Aulopora* and described *Aulopora serpens*, *A. tubaeformis*, *A. spicata*, *A. conglomerata* and *A. compressa*. The first three of these species are from the Devonian of Eifel, Germany. The original diagnoses and descriptions of the genus and of the genotype *A. serpens* in Latin and German are quoted verbatim by Fenton and Fenton, 1937, p. 109–110.

2. In 1847 Frederick M'Coy introduced the genus *Cladochonus* for tabulate corals from the Dunvegan shale, Lower Carboniferous of New South Wales, Australia. He clearly indicated the difference which distinguished his new genus from *Aulopora* Goldfuss, and concluded that some of the species formerly (1844) described by him under the generic name *Jania* Lamouroux (when he was "uncertain where to place them"), should now be referred to *Cladochonus*. These are *Jania crassa* and *J. bacularia*. The only Australian species which he illustrated and named is *Cladochonus tenuicollis* M'Coy.

3. In 1850 Milne-Edwards and Haime designated *C. tenuicollis* M'Coy as the genotype of *Cladochonus*.

4. In 1879 Nicholson and Etheridge erected a new genus, *Monilopora*, for *Cladochonus* (*Jania*) *crassa* (M'Coy), which they designated as the type of *Monilopora* (1879, p. 295).

5. Grabau, in 1899, accepted *Monilopora* as a valid genus and erected a new family, the Moniloporidae, which he introduced for it and his new genus *Ceratopora*. The latter was based on three new species from the Hamilton shale, Devonian of North America.

6. In 1925 Girty discussed *Cladochonus*, *Monilopora* and *Aulopora*, and suggested that *Monilopora* is a synonym of *Cladochonus*. Although the same conclusion was later reached by Hill and Smyth (1938), the latter authors point out that Girty's taxonomic arguments are invalid because they were based on the assumption that *C. crassus* is the type of *Cladochonus*, while, in fact, the type is *C. tenuicollis*.

7. In 1937 Fenton and Fenton revised the genus *Aulopora* and proposed that it be accepted as a *form-genus* including not only members of *Aulopora* proper but also "undetermined corals and bryozoans" (1937, p. 144) of the Hederelloidea. They sectioned "authentic specimens of *Aulopora serpens* Goldfuss," (but did not illustrate the sections) from Eifel (1937, p. 109), and illustrated in natural size two specimens of this species from the University of Michigan collection (pl. 5, figs. 2 and 3, on p. 127). They also introduced the new genus *Aulocaulis* for some Devonian species previously classified with *Aulopora*, and designated *Aulopora expansa*, Fenton and Fenton as the genotype.

8. In a paper devoted to the Hederelloidea Bassler (1939, p. 26) summarized briefly the distinction between the Hederelloidea and the Auloporidae "including Moniloporidae of Grabau," but did not analyze or mention the paper by Fenton and Fenton of 1937. None of the eleven Devonian species which were assigned by Fenton and Fenton (1937, pp. 114–115) to the form genus *Aulopora*, but considered by them to be bryozoa of the order Hederelloidea Bassler, is included by Bassler (1939) in Hederelloidea.[1]

[1] *Aulopora conferta* Winchell from the Devonian of Michigan listed by Fenton and Fenton

ESSENTIAL DATA FOR RECOGNITION

No attempt is made here to indicate which of the numerous species already described is to be assigned to one or another of the discussed genera, but the features which are established on the respective genotypes and, in some cases, on additional selected species whose generic classification seems to be well established, are summarized uniformly for each genus (see tabular key). The following are the most complete published definitions of the respective genera under discussion.

AULOPORA Goldfuss

Revised definition by Fenton and Fenton (1937, p. 110):

Colony consisting of small tubes; adnate, prostrate, or prostrate basally with erect or more probably pendant compound branches. Reproduction by basal or lateral gemmation. Tubes calcareous or perhaps even chitinous, the former predominating; their walls non-cystose, smooth to wrinkled externally, smooth or pustulose internally. Tabulae (or diaphragms), when present, variably convex toward the apertures. Tubes not continuously united, except in rare instances in which calcification is incomplete.

Contrary to the suggestion by Fenton and Fenton that the branches are "probably pendant," I wish to point out that all coralla observed *in situ* in the Pennsylvanian of the northern Midcontinent area extend upward and show negatively geotropic growth of the distal parts of the corallites.

The diagnosis of the genus which is entered in the table, is based on analysis of work by Goldfuss and Fenton and Fenton, and on personal observations.

Geologic range.—Chiefly Devonian and Carboniferous, a few Silurian species (Fenton and Fenton).

CLADOCHONUS McCoy

Original definition by M'Coy (1947, p. 227):

Polypidom of very thick, straight, slender, calcareous tubes, suddenly dilating at short regular distances into large, oblique, cup-shaped terminal chambers, longitudinally striated within, from the point where the dilation commences, a second slender tube similar to the first is given off at an angle varying with the species, and terminating at same distance as the former in a similar cap, but in nearly an opposite direction to the first, and giving rise at its base to a third slender tube as before. The whole polypidom erect, attached by the base only, which embraces some foreign body.

The revised definition by Hill and Smyth (1938, p. 127, "based on the two species examined"), is as follows:

Corallum compound, with a reptant ring of corallites proximally, from which free branches arise, individual corallites trumpet or pipe-shaped, and in contact only at the point of origin, each giving rise to another by lateral increase through the wall of the expanded calice, each has a thick, peripheral stereozone of laminar sometimes reticulated, sclerenchyme; neither tabulae nor septal spines are seen in the narrow lumen, but longitudinal (? septal) ridges may appear in the calices.

Geological range.—Lower Carboniferous (Mississippian).

Aulocaulis Fenton and Fenton.

Diagnosis, as given by Fenton and Fenton (1937B, p, 119-120):

Corallum prostrate, linear or reticulate. Corallites thin-walled, depressed, smooth or indistinctly wrinkled. Throughout most of their length they show little or no expansion; then they expand abruptly into subcircular apertural regions whose diameter is 1.5 to 4 times that of the tubular portions of the corallites. The apertures are directed vertically and are but slightly elevated above the tubes. Tabulae few or absent; septal ridges present. Some species bear an indistinct dorsal ridge on most or all corallites . . . . Reproduction chiefly by terminal budding, branching or in linear series.

Geologic range.—Devonian.

For the diagnosis of *Hederella* by Bassler (1939) see the preceding paper by Condra and Elias (1944).

A direct comparison of the generic diagnoses just quoted shows how different were the individual points of view and the technical language of the different authors who studied these fossils. For the convenience of comparison in routine paleontologic work the essential data for each of the genera are abstracted and presented in the appended key-table.

Examples of auloporids from the American Carboniferous are illustrated by Keyes (1894, p. 123, pl. 14, fig. 8), Beede (1900,

under Hederelloidea (1937, p. 115), is not the same species as *Hederella conferta* Hall from the Devonian of New York (see Bassler, 1939, p. 50, pl. 9, figs. 4, 5).

pp. 23–24, pls. 3–5, and 1906, pp. 1212–1216, pl. 11, figs. 5–6a), Mather (1915, pp. 98–99, pl. 1, figs. 3–6), and others.

DIFFICULTIES IN RECOGNITION AND TAXONOMIC IMPLICATIONS

Uncertainties in the identification of the genera under discussion, which created many difficulties in the past, are due to several causes. Goldfuss in his original description and illustrations of *Aulopora* included a few examples which probably do not belong there, but their generic and specific reassignment cannot now be assuredly accomplished except by examination of the originals or of topotypes. Because the wall structure of *Aulopora* was not originally studied, the comparisons with it of the subsequently erected genera could not be complete and thus their differentiation was uncertain. Lack of agreement in recognition of the types of *Aulopora* and *Cladochonus* added to the complexity of this problem. Finally, Fenton and Fenton pointed out that manner of budding and size of tubes cannot always be relied upon to distinguish between the tabulate corals commonly referred to *Aulopora* and the very similar tubular hederelloid Bryozoa. Consequently they suggested that *Aulopora* be considered a form-genus including both tabulate corals and the similar appearing Bryozoa. At the same time, however, they used the generic name *Aulopora* in a restricted sense (*sensu stricto*) for many American species and for the genotype, *A. serpens* Goldfuss (Fenton and Fenton, 1937, p. 114) with the understanding that in this case *Aulopora*, s.s., indicates tabulate corals only.

The use of a generic name in both comprehensive and a restricted sense occurs extensively in connection with both living and fossil organisms. Usually this is the outcome of subsequent splitting of old comprehensive generic groups (like living *Panicum*, a grass), or of splitting of so-called polyphyletic genera (like fossil *Scaphites*, an ammonite). The case of *Aulopora*, however, presents particular complication because in its comprehensive sense, as proposed by Fenton and Fenton, it would include fossil animals of unrelated phyla: corals and bryozoa. This suggestion, if accepted, would remove the name *Aulopora* from the natural or Linnean classification of organisms and apparently throw in into the utilitarian or "military" classification suggested by Croneis for fossil fragments whose nature is not adequately known. Although the "utilitarian" classification was originally suggested for small and fragmentary "micro-fossils" it seems to me that it is not, or should not be, the size or degree of completeness of a fossil but rather our lack of understanding of its characters that precludes its classification in the Linnean system and makes it eligible only for the "utilitarian" system of classification.

If *Aulopora* is to be used in two senses, as suggested by Fenton and Fenton, and in two systems of classification, as one must necessarily conclude, the question arises: how can we recognize in which sense it is used in any particular case? The use with a generic name of the abbreviations *s.s.* and *s.l.*, denoting *sensu stricto* and *sensu lato*, does not seem to be quite adequate, because these, as commonly understood, indicate different usages of a generic name within the Linnean system. Perhaps the best solution of this problem would involve the introduction of a new generic name to designate *Aulopora*-like forms in the utilitarian sense; and the use of the name *Aulopora* in its restricted sense only.

It is not certain at present, however, that it would be advantageous and practicable always (or as a rule) to use different names in the Linnean and "utilitarian" classifications, and to change the name of a fossil when it is transferred from one to the other. In paleobotany the meanings of many generic names are constantly changing and may, from time to time, refer to natural, artificial or arbitrary groups, depending on the progress of research. The same may also be true in the cases of *Aulopora* and some other animal groups. New specimens of old species eventually may be secured which will provide a better understanding of such features as wall-structure or initial developmental stages. Increased knowledge thus obtained may result in the transfer of certain species from the utilitarian to the Linnean classification.

Most paleontologists agree that there are already too many generic (and other) names and that the number of new names is grow-

CHARACTERS OF HEDERELLA AND SOME ADNATE TUBULATE CORALS

Genera	*Hederella*	*Aulocaulis*	*Aulopora*	*Cladochonus* (= *Monilopora*)	*Ceratopora*
Budding	Lateral to basal	Subterminal	Subterminal to lateral	Subterminal	Subterminal to lateral
Growth-form	Straight or curved, branching rows of tubes: (1) uniserial rows with distal parts of tubes turned right and left; or (2) pluriserial rows made of subparallel tubes; or (3) irregularly bunched tubes.	Tubes in linear series, branching or reticulate	Tubes in zig-zag series; to reticulate or massive.	Tubes in attached ring, with free zig-zag branches.	Tubes in zig-zag series, branching or reticulate
Attachment and Orientation	Wholly attached except diagonally upturned to upright apex.	Wholly attached except upright apex	Partly or wholly attached except diagonally upturned to upright apex	Almost wholly attached; apices turned right and left in plane of budding	Rarely attached above base, apex turned upright
Shape	Uniform diameter, somewhat contracted at apex.	Uniform diameter, expanding suddenly at points of budding.	Uniform diameter to gradually expanding*	About equal in diameter below budding; with sudden expansion at point of budding	Gradually expanding toward point of budding, with no increase in diameter, to contracting above point of budding.
Diameter	0.15 to 1 mm.; rarely 1.5 mm.	1.5 to 2.5 mm.	2 to 4 mm. in genotype	0.9 to 2 mm. proximally; apex expands 1.5 to 2 times	1.5 to 3.5 mm.
Apertures	Constricted, oval; long diameter transverse to axis; upward facing.	Circular, slightly constricted; upward facing.	Circular, slightly constricted; upward facing.	Circular, variously directed	Circular, upward facing
Septal structures	None	With septal ridges	None; or septal ridges† or spines may be developed	Longitudinal septal ridges may appear in apical parts	None
Tabulae (diaphragms)	None	Few or absent	When present variously convex toward aperture	None	None
Walls	Thin, about 1/10 diameter, perforate	Thin	Thick, 1/5 diameter or more, solid, non-laminated.	Thick, $\frac{1}{4}$ to $\frac{1}{3}$ diameter, solid, with growth laminations.	Thin, about 1/10 diameter, much increased proximally by numerous inner lamellae.

ing alarmingly. Although further introduction of new names for newly discovered fossil and living organisms is inevitable the erection of new names for the old and well-known fossils should be avoided wherever possible. If a genus is transferred from the Linnean to a utilitarian classification, or vice versa, or if our understanding of a genus changes, this change could be indicated in some manner other than by the introduction of a new name. The following is offered as a method of signifying in which particular sense a generic name is used.

A generic name may be used in such a way that one of several different meanings may be implied but which meaning is intended is not always clear. This unfortunate situation is an inevitable consequence of the variable degrees of preservation of fossil organisms and imperfection in methods of study, which gradually improve. If a fossil organism could be known in all its details, as many living animals are known, there would still remain the difficulty of determining its natural place among other organisms. Even complete morphological and anatomical knowledge of a species would not solve all difficulties involved in its classification.

Some generic names now applied to fossils are admittedly arbitrary and are known or suspected to include species which are only distantly related. These are called form-genera or artificial genera. Among them belong many genera established on fragmentary sterile parts of fossil plants. When the nature of a fossil is considered satisfactorily understood, as with most fossil molluscan and molluscoid shells, the genera established for them are considered natural. Some seemingly natural genera, however, have been proved polyphyletic, and their component species are now known to have arrived at similar evolutionary stages at the same or different times in different phyletic branches or evolutionary series. Such, for instance, are the species of the ammonite genus *Scaphites*, of the fusulinid genus *Schwagerina* (in the old sense), and numerous others.

Some paleobotanists recently have proposed to group in combination genera all of the various parts of plants which are usually found separated, but are satisfactorily proved to belong together and the special generic names for these assemblages may differ from those employed for each part separately.

In paleobotanical practice, however, it is the custom to apply the name of the most commonly collected part to the complete plant. Thus *Lepidodendron* is used both for the bark and the whole reconstructed plant. Likewise the name *Cordaites* is applied both to leaves and to the complete plant.

A special utilitarian system of classification has been suggested for microfossils whose nature is unknown or impossible to establish (Croneis, 1938). The names used in this classification are entirely arbitrary and do not define any particular organism but are used merely to designate fragments or parts of various fossils which are superficially similar.

Because of the tremendous number of fossil names already in use it seems to me that the coining of new names for fossils already well known or for their parts should be avoided. Instead, a familiar name may be used to designate (1) the whole plant or animal as visualized or actually restored; (2) the part of a fossil organism that is used as an index-fossil (shell of a mollusk, leaf of a tree); or (3) a mere "marker" used in correlation of formations penetrated by deep wells. Each of these concepts can be distinguished from the others by prefixing an appropriate symbol to the generic name.

Thus, letters of the Greek alphabet might be used to designate the following meanings of the name *Aulopora:*

η *Aulopora—natural genus* of a tabulate coral.

ϕ *Aulopora—form genus* or *artificial genus*, as per original suggestion by Fenton and Fenton

μ *Aulopora—utilitarian* or "*military*" genus of uncertain biologic affinity, in modification of Fenton and Fenton's suggestion.

χ *Aulopora—composite genus*, to designate

FOOTNOTES FOR TABLE

* Some Devonian species expand abruptly at points of budding according to Fenton and Fenton.

† Shown on the sketch of *Aulopora tubaeformis*, Goldfuss (1826–33, pl. 29, fig. 2b); also observed by me in a new species of *Aulopora* from the Upper Mississippian at Flux, Utah.

completely known corallum, including the initial corallite, when such is found.

The use of such symbols would also at once distinguish fossil genera from living ones. For many years some paleobotanists have wished to indicate that a generic name refers to fossil rather than living plants, when the relations of similar forms cannot be proved. Seward (1898, p. 256) recommended that the ending of a modern generic name be changed for use with fossil specimens. Thus the name *Equisetites* Sternberg would be used for all fossils which show features typical of living *Equisetum*. Many paleozoologists, however, have not hesitated to extend the name of the living genus *Lingula* to all apparently similar fossil shells, including those from the earliest Paleozoic, in spite of the fact that their generic identity cannot be proved because soft parts are not available for study.

The use of a prefixed symbol with each fossil generic name would make this distinction clear and the name *Equisetum*, for example, with a proper symbol could be used for any fossil which is apparently identical with this living genus, whether it occurs in rocks of the Pleistocene, Tertiary, Mesozoic or Paleozoic ages. At present the choice between the names *Equisetum* or *Equisetites* for fossil plants is entirely arbitrary. Paleobotanists have good reasons to believe that Pleistocene remains of this kind belong to the genus *Equisetum*. Perhaps most of them feel that Tertiary specimens too should be classified as *Equisetum* rather than *Equisetites*. As yet, however, no significant criterion has been determined by which the Tertiary, Cretaceous or still older fossils can reasonably be classified as one rather than the other.

In oral presentations or discussions, there is no need to indicate the symbol placed in front of a generic name (like η *Aulopora*), unless the nature or preservation of the fossil is particularly stressed or special attention is called to this part of a problem. In written and in published records, however, this simple and inexpensive (in printing) addition seems to be desirable and practicable. It furnishes an immediate understanding of the sense in which the name is used or of the type of preservation of the fossil. I do not wish to be dogmatic about the adoption of this system, however, and I have no desire to force this procedure upon others. On the other hand a trial can result in no possible harm and experience alone will show whether it is practicable and convenient, either in this form or in some modification.

Criticism and discussion are cordially invited.

REFERENCES

BASSLER, R. S., 1939, Hederelloidea, a suborder of Paleozoic cyclostomatous bryozoa: Proc. U. S. National Museum, vol. 87, pp. 25–73, text fig. 14, and 16 pls.

BEEDE, J. W., 1900, Carboniferous invertebrates: Kansas Geol. Survey, vol. 6, 187 pp., 22 pls.

——, 1906, Fauna of the Salem limestone of Indiana, Anthozoa: Indiana Dept. Geol. and Nat. Res., 30th Ann. Report, pp. 1202–1218, pls. 7–11.

CONDRA, G. E., and ELIAS, M. K., 1944, *Hederella* and *Corynotrypa* from the Pennsylvanian: Jour. Paleontology, vol. 18, pp. 535–539, 3 pls.

CRONEIS, CAREY, 1938, Utilitarian classification for fragmentary fossils: Jour. Geol., vol. 46, pp. 975–984.

EDWARDS, H. M. and HAIME, J., 1850, Monograph of the British fossil corals: Palaeont. Soc. London Monogr. Pt. 1, vol. 75, 72 pp., 9, pls.

FENTON, A. F. and FENTON, C. L., 1937-A, Aulopora; a form-genus of tabulate corals and bryozoans: Am. Midland Naturalist, vol. 18, pp. 109–115, 1 text fig., pl. 5 (on p. 127).

FENTON, A. F. and FENTON, C. L., 1937-B, *Aulocaulis*, a new genus of auloporoid corals: idem, vol. 18, pp. 119–120, text figs. 1–2.

GIRTY, GEORGE H., 1925, On the genera *Cladochonus* and *Monilopora*: Jour. Geol., vol. 33, pp. 19–27.

GOLDFUSS, A., 1826–1833, Petrefacta Germaniae. Düsseldorf.

GRABAU, A. W., 1899, Moniloporidae, a new family of Paleozoic corals. Boston Soc. National History Proc., vol. 28, pp. 409–424, 4 pls.

KEYES, C. R., 1894, Paleontology of Missouri: Missouri Geol. Survey, vol. 4, pt. 1, 271 pp., 32 pls.

MATHER, K. F., 1915, Fauna of the Morrow group of Arkansas and Oklahoma: Denison Univ. Bull. Jour. Sci. Lab., vol. 18, pp. 59–284, 16 pls., 1 table.

M'COY, F., 1847, On the fossil botany and zoology of the rocks associated with the coal of Australia: Annals and Mag. Natural History, vol. 20, pp. 145–157, 226–236, 298–312, pls. 9–17.

NICHOLSON, H. A. and ETHERIDGE, R., Jr., 1879, On the microscopic structure of three species of the genus *Cladochonus* M'Coy: Geol. Mag., (Dec. 2,), vol. 6, pp. 289–296, pl. 7.

SEWARD, A. C., 1898, Fossil plants, vol. 1, pp. xviii+452, III. text figs., frontispiece.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 535–539, PLS. 89–91, NOVEMBER 1944

HEDERELLA AND CORYNOTRYPA FROM THE PENNSYLVANIAN

G. E. CONDRA AND M. K. ELIAS
Nebraska Geological Survey, Lincoln

ABSTRACT—Two new bryozoan species, referred to *Hederella* and *Corynotrypa* respectively, are described from beds of Pennsylvanian age, thus greatly extending the previously known stratigraphic ranges of these genera.

PART I. HEDERELLA

INTRODUCTION

BASSLER, in his monograph on the Hederelloidea, a suborder of Paleozoic cyclostomatous bryozoa, stated that this suborder "so far as known becomes extinct with the close of the Paleozoic" (Bassler, 1939, p. 25), but does not indicate its occurrence in beds younger than the Chester. At about the time he wrote this statement the presence of *Hederella* in the upper part of the Manning Canyon shale, Pennsylvanian of Utah, was recorded by Girty (in Gilluly, 1932, p. 33), who lists *Hederella* n. sp. among other invertebrate fossils.

We have not examined Girty's specimen from the Manning Canyon shale, but we have found small groups of *Hederella* zooecia adnate on the shafts of *Archimedes gillulyi* Condra and Elias, and on fragments of other fossils from the Oquirrh formation in the Stockton area of Utah, that is probably slightly younger than the Manning Canyon shale. These specimens, together with the conspecific material from the lower and middle Pennsylvanian rocks of Oklahoma, are described below.

We have not found representatives of the Hederelloidea in Nebraska or Kansas and the occurrence of *Hederella* in the Dewey limestone of the Missouri series (Middle Pennsylvanian) at Bartlesville, Oklahoma is the stratigraphically highest record of the genus known to us.

DISCUSSION

Bassler, to whom we are indebted for the recent comprehensive description and revision of *Hederella* and related Hederelloidea, (1939, p. 28) defined the genus *Hederella* as follows:

Zoarium attached to various foreign organic objects and rarely to pebbles or other inorganic substances, branching, consisting of a tubular axis composed of the earlier part of successive zooecia from which the zooecia bud laterally, alternately to right and left; tubes annulated transversely but finely striated longitudinally; apertures terminal, transversely-elliptical.

He gave the range of the genus as Middle Silurian to Mississippian. The genotype is *Alecto canadensis* Nicholson, 1874.

Our species from the Pennsylvanian rocks correspond well to this diagnosis and stand fairly close to *Hederella chesterensis* Bassler, except that we do not find any trace of longitudinal striae. In his descriptions of 62 species of *Hederella*, however, Bassler did not refer specifically to the longitudinal striae, thought to be present as per the diagnosis of the genus, and probably these striae are very seldom observed, but he did describe the transverse annulations and wrinkles in nearly all of these species, though they are very faint in some forms.

The similarity of the zoarium of *Hederella* to the chain-like corallum of *Aulopora* was discussed by Bassler (1939, p. 26) who noted that "Auloporidae, including Moniloporidae of Grabau," are "still larger tubular organisms," . . . They "have terminal gemmation instead of a lateral buddings with no line of separation at the surface, circular orifices, and thick imperforate walls." To this must be added the following features which elsewhere he considered common to all Hederelloidea: "tubular zooecia with perforated walls derived from a bulbous ancestrula, as in typical *Cyclostomata* . . . apertures transversely elliptical and terminal."

Resemblance between the respective colonial growth forms of adnate *Aulopora prosseri* Beede on lophophyllid corals (pl. 89, fig. 6) and *Hederella* is pronounced, but the two are fundamentally different in structure and thickness of walls, and in the manner of budding. Where *Hederella* is not adnate to such wide flat surfaces but is attached to narrow shafts of *Archimedes* (pl. 90, fig. 4)

or to fragments of various shells (pl. 89, figs. 4, 5 and pl. 90, 3 and 5) its colonial growth form loses its characteristic regularity and the budding tubes become variously bunched into irregular groups. However, the true hederellid nature of such specimens can be still recognized notwithstanding their irregular growth as they retain the size of individual tubes, thickness and structure of walls, and the manner of lateral budding.

Thin sections (pl. 89, fig. 3) show the structure of the wall in *Hederella carbonaria*, n. sp., although its inner surface is not sharply separated from secondary calcite filling the inside of the crushed tubes. The wall is differentiated into an inner part which is more transparent, and an outer part, which appears darker and is less transparent in the slide. The dividing line between these two parts is not sharp but the outer part is clearly much thinner than the inner part, in the ratio of about 1 to 4 or 5. The inner part shows very faint transverse striae separated by distances of from 3 to 5μ, that is there are from 200 to 330 striae in 1 mm. These striae may indicate the original perforations of the wall which were nearly obliterated by secondary recrystallization.

No distinct orientation of crystalline fibers in the walls is revealed by polarized light either in transverse or longitudinal sections, and no dark cross was observed (with crossed nicols) as in the transverse sections of *Cladochonus* walls (Hill and Smyth, 1938, pl. 23, figs. 9, 10).

Thickness of the wall in the mature part of *H. carbonaria* is about 0.08 mm., but in the initial part of a budding zooecium it is much thinner, about 0.03 mm. Also the wall facing the surface of attachment is thinner than the outer wall, about 0.05 mm. in the adult part of a zooecium.

HEDERELLA CARBONARIA Condra and Elias, n. sp.

Plate 89, figures 1–5; Plate 90, figures 1–5

? *Hederella* n. sp., Girty, 1932, in Gilluly, U. S. Geol. Survey Professional Paper 173, p. 33.

Description.—Zoaria of specimens from the Dewey limestone are dendritic and usually adnate upon lophophyllid corals. Their most characteristic specific feature is the irregularity of both budding and branching, so that it is difficult to establish the average figures for the intervals at which budding and branching take place. The zoarium is a chain of tubular zooecia which, at some places, alternate in budding to right and left, but almost as frequently successive buds appear on the same side (see pl. 89, fig. 2, just below the middle) or the zooecia are crowded as the result of nearly spontaneous budding at a single point (pl. 90, fig. 5). The main axis is curved as it progresses upward, swinging to the right or left without much regularity. Lateral branches are given off at intervals usually varying from 6 to 7 mm. and at angles varying from about 45° to 60°. They also curve in the same irregular fashion, but oftener downwards than upwards. The main branch of some specimens makes a complete 180° "hair-pin" curve and proceeds in a direction opposite and parallel to its earlier growth (see pl. 90, fig. 1, extreme left side.)

The width of an adult zooecium is about 0.4 to 0.6 mm. measured more or less on crushed tubes which is therefore wider than the original diameter of unbroken tubes. The diameter of uncrushed tubes is probably

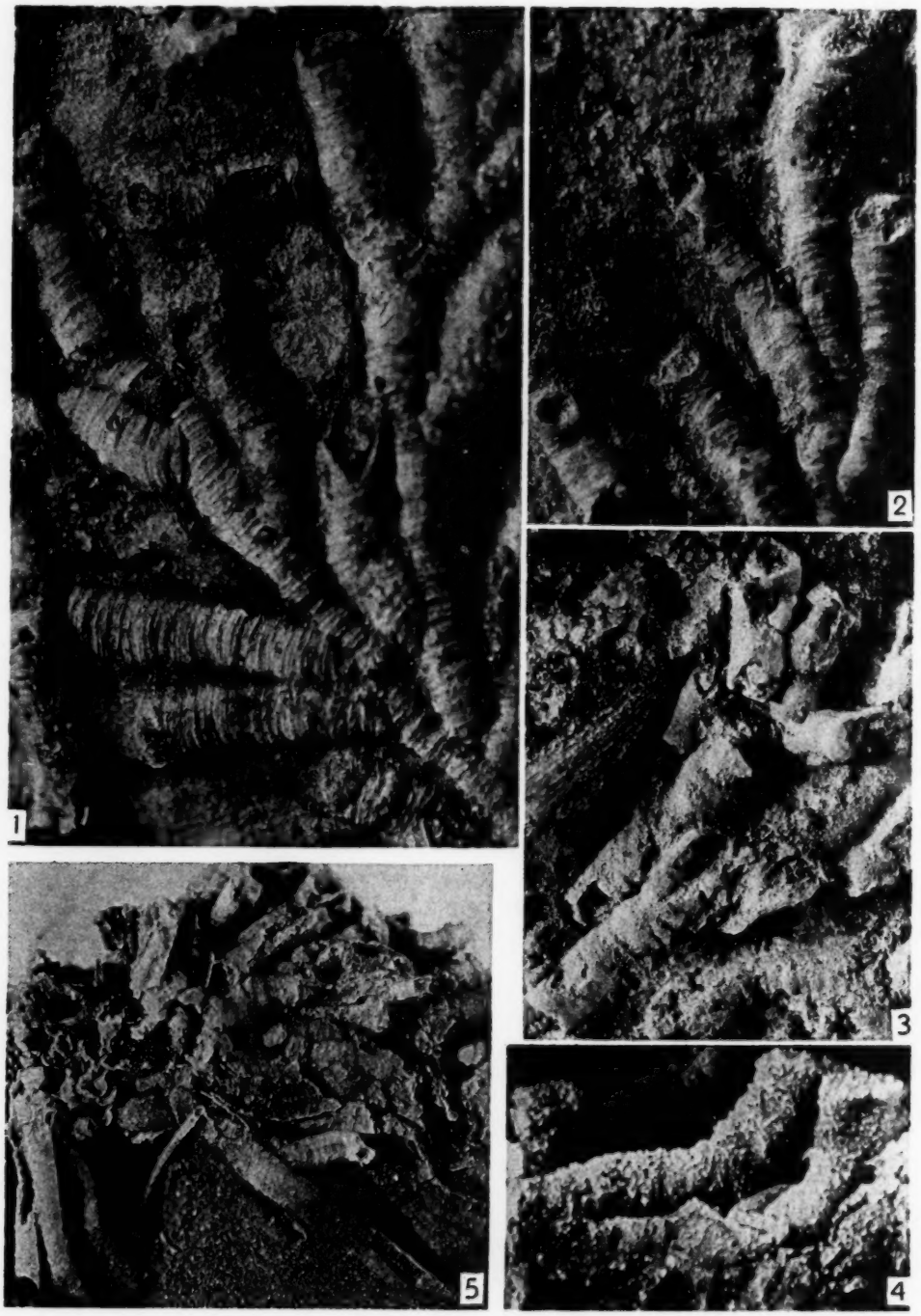
---

EXPLANATION OF PLATE 89

FIGS. *1–5*—*Hederella carbonaria*, n. sp. *1–3*, On lophophyllid coral. *1* (NGS 451), *2* (451-A), ×2; 3, ×40 (thin section). Type numbers. *3*, Thin section NGS B-3 of somewhat crushed zooecial tube; *a*-wall, *b*-inner space filled with crystalline calcite. Zooecial wall inked in; microstructure of the wall not retouched. *4, 5*, On debris of fragments of *Polypora* and *Fistulipora* mixed with sand. ×10. Type number NGS 453-A and 453-B. Specimens from sandy shale below Dewey (=Iola) limestone, Missouri group, Pennsylvanian. Cut on U. S. highway 75, 2 miles south of Bartlesville, Oklahoma.

6—*Aulopora prosseri* Beede. On lophophyllid coral, ×2. Illustrated for comparison with *Hederella*, showing different size and apical instead of lateral (as in *Hederella*) budding of a similar growth form. Beil limestone, Shawnee group, Virgil series, Pennsylvanian. Snyderville quarry, 1 mile north, 3 miles west of Nehawka, Nebraska. Type number NGS 452.

Condra and Elias – Pennsylvanian Bryozoa



Condra and Elias – Pennsylvanian Bryozoa

about .35 to nearly 0.4 mm., which corresponds to measurements of uncrushed silicified tubes of *H. carbonaria* adnate on *Archimedes gillulyi* from Stockton, Utah (see pl. 90, fig. 4).

Length of the tubes usually varies from 2 to 3 mm. but the tubes of the main branch occasionally are much longer, up to about 7 or 8 mm. Perhaps this greater length of tubes in the main branch is related to their ability for occasional more prolific closely spaced budding which produces a cluster of lateral zooecia of normal length.

The apex of each zooecium is turned up sharply nearly perpendicular to the surface of adnation and is short and contracted in diameter. The aperture is contracted with its long diameter perpendicular to the axis of the adnate part of the zooecium and is about 0.3 to 0.32 mm. in length.

Transverse sculpture of the zooecia is conspicuous, and consists of a succession of similar annulations, about 30 in 1 mm. Neighboring annulations differ slightly in diameter and some are a little more prominent not because they are wider but because they are of greater diameter and thus project slightly above their neighbors (see pl. 90, fig. 1).

Discussion.—Hederella carbonaria is similar to *H. chesterensis* Bassler in general character of zoarium and irregularity of budding, but differs in the greater diameter of its zooecial tubes. It belongs, together with *H. chesterensis*, in section 4 of Bassler, which is typified by *H. canadensis* (Bassler, 1939, p. 30–31).

The tendency to irregular budding and branching, as displayed by *H. carbonaria*, *H. chesterensis* and related forms, seems to be characteristic of these late Paleozoic species and may indicate gerontic racial decline of the stock prior to its extinction. *H. carbonaria* appears to be the last survivor of the suborder, which attained its greatest development in Devonian time. Only one species each is known from the Warsaw, Chester, and Lower Pennsylvanian (to Middle Pennsylvanian) formations.

Occurrence.—1. The largest number of specimens was obtained through repeated collecting, chiefly by Condra, of lophophyllid corals from the basal part of the Dewey limestone, in the cuts of U. S. highway 75, about two miles south of Bartlesville, Oklahoma, and collecting from the cement company quarry located east of Dewey, Oklahoma. South of Bartlesville, one specimen was obtained in which *Hederella carbonaria* adheres to an aggregate of sandy material and small fragments of *Polypora* and *Fistulipora* (pl. 89, figs. 4 and 5; pl. 90, fig. 2).

2. A small group of partially fragmented zooecia of this species was found in the Wapanucka limestone at Chockie, Oklahoma (pl. 90, fig. 3). In this specimen also, *H. carbonaria* is adnate upon an aggregate of fragmentary larger fossils: echinoid spines, crinoid joints, fragments of fenestrate bryozoa, etc. The tubes in this specimen show only faint transverse wrinkles, but this may be due to its less perfect preservation. The small specimen shows no other features on which it can be differentiated from *H. carbonaria*.

3. Specimens of *Hederella* sp., which is listed by Girty among the Pennsylvanian fossils of the Manning Canyon shale (in Gilluly, 1932, p. 33), have not been studied, but we found scattered groups of tubes, undistinguishable from the Bartlesville specimens, adnate to an *Archimedes gillulyi* shaft and fragments of other fossils (pl. 90, fig. 5) in a collection of the U. S. Geological Survey from the Oquirrh formation at Stockton, Utah (pl. 90, fig. 4).

Girty's form probably should be identified with our species.

EXPLANATION OF PLATE 90

FIGS. *1–5—Hederella carbonaria*, n. sp. *1*, On lophophyllid coral. Type number NGS 451. *2*, Debris of fragments of *Polypora* and *Fistulipora* mixed with sand. Type number NGS 453. From same locality as specimens of pl. 89. ×20. *3*, On fragmentary fossil material. Wapanucka limestone, Lower Pennsylvanian. Chockie, Oklahoma. Type number NGS 454. ×20. 4. On Shaft of *Archimedes gillulyi* Condra and Elias (Geol. Soc. Am. Spec. Pap. 53, p. 169). Type number USGS. 5194-A. ×20. *5*, On fragmentary fossil material. Type number NGS 455, ×10, *4*, *5*, from Oquirrh formation, at Stockton, Utah.

REFERENCES

BASSLER, R. S., 1939, Hederelloidea, a suborder of Paleozoic cyclostomatous bryozoa: U. S. Nat. Mus. Proc., vol. 87, p. 25–91, 1 text fig., 16 pls.

GIRTY, G. E., 1925, On the genera *Cladochonus* and *Monilopora*. Jour. Geol., vol. 33, p. 19–27.

——, 1932, in Gilluly, James, Geology and ore deposits of the Stockton and Fairfield quadrangles, Utah: U. S. Geol. Survey Prof. Pap. 173, 165 p., 22 text figs., 32 pls. Discussion of the Mississippian and Pennsylvanian fossil collections by Girty, p. 33–34 and 36–37.

GRABAU, A. A., 1899, Moniloporidae, a new family of Paleozoic corals: Boston Soc. Natural History Proc., vol. 28, p. 409–424, 4 pls.

Note: For earlier literature on Hederelloidea see Bassler, 1939, listed above, and Nickles and Bassler, 1900, A synopsis of American fossil Bryozoa; U. S. Geol. Survey, Bull. 173, p. 280–282, 288, 385–386.

PART II. CORYNOTRYPA

INTRODUCTION

This interesting but misunderstood genus has been wrongly classified by some, and error and dispute regarding its occurrence and geologic range have arisen. We describe a new species from beds high in the Pennsylvanian subsystem, thus extending its range upward from the Devonian.

Bassler (1911, pp. 501–503) redefined *Stomatopora* and separated from it the new genus *Corynotrypa*. His diagnosis of the latter is as follows:

> Zoarium adnate, consisting of simple, subtubular zooecia arranged in single-branched series; zooecia oval-pyriform to elongate clavate, the proximal end constricted and united with the preceding zooecium by a narrow, tubular stolon of variable length; the distal portion more or less expanded and bearing on its frontal side the aperture which is subterminal, circular, and enclosed by a more or less distinct, slightly elevated peristome; walls finely porous. Genotype, *Stomatopora delicatula* James. . . . Range of genus, base of Ordovician to close of Mesozoic; possibly also Cenozoic. . . . The apparent absence of the genus in the known Mississippian, Pennsylvanian and Permian rocks may be due to lack of systematic search, but it is nevertheless a curious fact that all of the simple cyclostomatous Bryozoa have a similar geologic distribution.

A letter from Dr. Bassler in 1939 states, however, that the Mesozoic and Cenozoic species referred to *Corynotrypa* belong to Cheilostomata. Thus the recorded occurrence of the genus in the Mesozoic and Cenozoic is in error, and true *Corynotrypa* has not been recorded previously above the Devonian.

DISCUSSION

Bassler (p. 501) stated:

> The closest ally of *Corynotrypa* is undoubtedly the well-known and even more widely distributed and longer-lived *Stomatopora*. The two genera agree in having an incrusting zoarium composed of simple, porous, tubular zooecia arranged uniserially. *Corynotrypa* differs from *Stomatopora* most obviously in the constriction of the proximal end of the zooecium, giving it the characteristic clavate to pyriform shape which causes each to stand out as an individual. In *Stomatopora* the successive zooecia form a narrow branch with more or less parallel sides in which the individuals are scarcely delimitable except by their apertural openings.

As noted before, *Corynotrypa* includes species formerly classed with *Stomatopora*. The genus has been confused with *Vinella*, *Rhopalonaria* and *Ascodictyon*, which are ctenostomatous Bryozoa, also with Triassic and other Mesozoic forms which are cheilostomes, and even with *Aulopora*, which is a coral.

CORYNOTRYPA THOMASI Condra and Elias, n. sp.
Plate 91, figures 1–4

In 1930 the late Dr. A. O. Thomas of the University of Iowa, discovered several unusual bryozoan specimens in the Spring Branch limestone of the Lecompton formation at the Snyderville quarry near Nehawka, Nebraska. These specimens were placed in the Nebraska Geological Survey

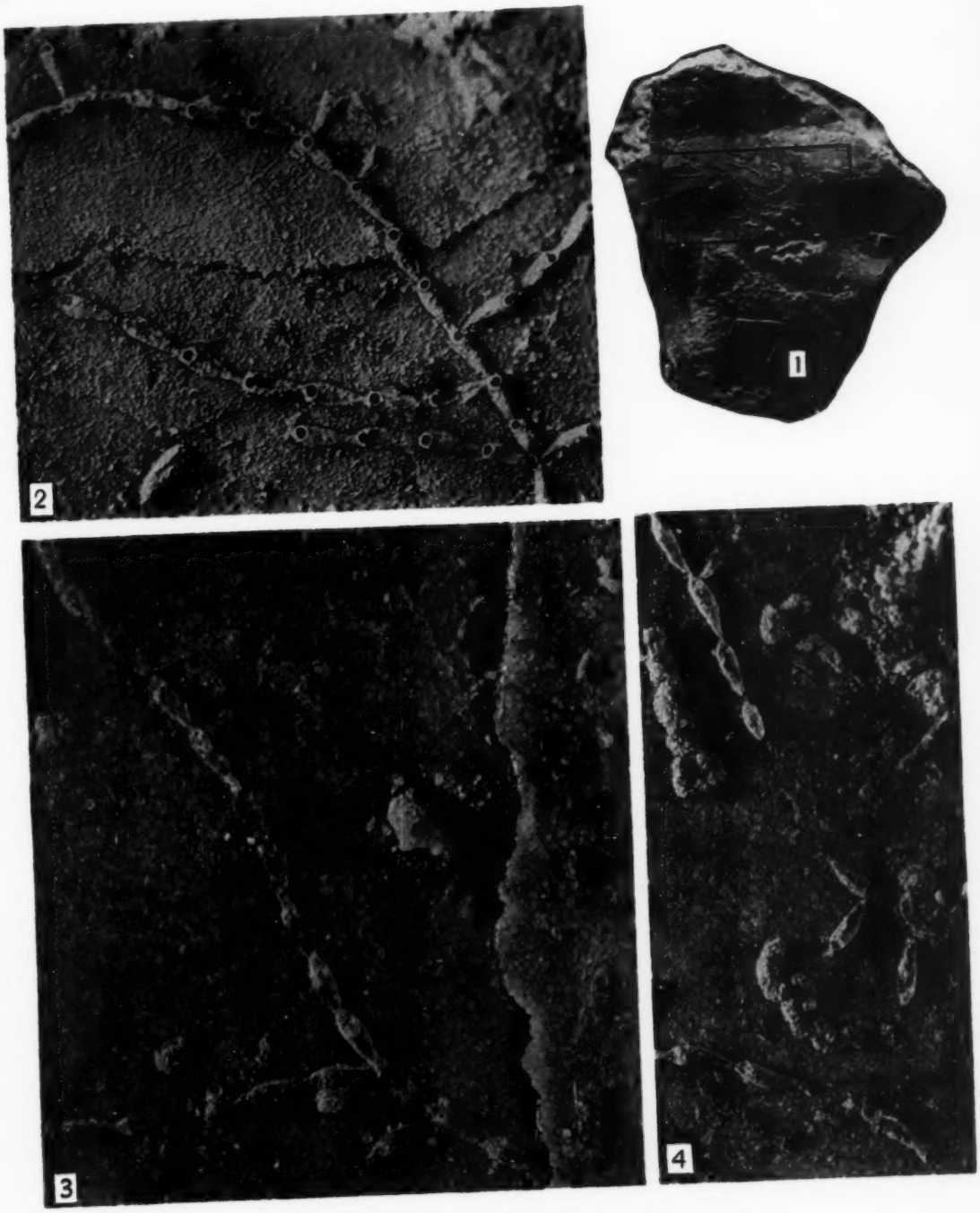
---

EXPLANATION OF PLATE 91

FIGS. *1–4*. *Corynotrypa thomasi* Condra and Elias, new species. On inner side of nearly flat valve of *Pinna peracuta*.

1, 2, Holotype, NGS 256. Spring Branch limestone, Lecompton formation, Snyderville quarry, 3 miles west and 1 mile north of Nehawka, Nebraska. ×2, and ×20. *2*, slightly retouched.

3, 4, Homoeotype, NGS 258. Dover limestone. Near small dam south of Pawnee City, Nebraska. ×20.



Condra and Elias – Pennsylvanian Bryozoa

UNIV. OF MICH.

collection, and classed as a new species of *Corynotrypa* by Condra. About eight years later they were discussed with Dr. Bassler, who agreed with this classification, but on February 20th, 1939, he wrote:

> Since your visit I have been thinking about our discussion regarding *Corynotrypa* and wondering whether the specimens are really a *Corynotrypa* since this genus has heretofore not been found so high.

The holotype was sent him and he later wrote:

> The specimen collected by Dr. A. O. Thomas arrived safely and I find it to be a true *Corynotrypa*.

Description.—Zoarium adnate, not fully preserved, consisting of zooecia in primary and lateral ranges; lateral ranges spring from main range at nearly right angles. Zooecia tubular, club-shaped, quite uniform in size and form, increasing gradually in width distally to near aperture, then decreasing bluntly beyond aperture which is circular and nearly terminal. Measurements: length of zooecia 0.45 to 0.52 mm.; width at proximal end, 0.05 to 0.10 mm., at distal end, 0.15 to 0.17 mm.; zooecial apertures 0.06 to 0.07 mm. in diameter; peristome width 0.1–0.12 mm.

Remarks.—This species resembles the Silurian *C. dissimilis* Vine in the shape of zooecia, transverse wrinkles, right angle of branching, and the constricted, slightly elevated apertures. However, it differs from the latter and all other early Paleozoic species of the genus in the much smaller zooecia which are only about one-half as large as those of *C. dissimilis*.

Of the three specimens collected by Dr. Thomas, two are fragmentary, but one (the holotype) is well preserved.

Manuscript received February 1, 1943.

In 1942 Condra collected specimens of *Corynotrypa* from the Dover limestone high in the Wabaunsee series at the small dam just south of Pawnee City, Nebraska. This is several hundred feet higher stratigraphically than the Spring Branch limestone from which the original specimens were collected. They are slightly coarser than the others but we class them as *C. thomasi* without reservation.

Occurrence.—The holotype, no. 256, and the topotypes, no. 257 of the Nebraska Geological Survey collection are from the Spring Branch limestone member of the Lecompton formation, Shawnee group, Pennsylvanian subsystem, at the Snyderville quarry, 3 miles west and 1 mile north of Nehawka, Nebraska. A homoeotype, no. 258, is from the Dover limestone, Wabaunsee series, Pennsylvanian subsystem near Pawnee City, Nebraska. All specimens of this species were found on inner side of *Pinna peracuta* valves.

Close search should be made for more specimens of *Corynotrypa* in the Carboniferous and Permian formations. The established range of the genus is now Lower Ordovician to Upper Pennsylvanian with no species recorded from the Mississippian and only one from the Pennsylvanian.

REFERENCES

BASSLER, RAY S., 1911, *Corynotrypa*, a new genus of tubuliporoid Bryozoa, Proceedings U. S. Nat. Mus. vol. 39, pp. 497–527. This is the most complete publication on *Corynotrypa* and its species.

——, 1911, Early Paleozoic Bryozoa of the Baltic Province: Smithsonian Inst., U. S. Nat. Mus., Bull. 77, pp. 58–69.

ZITTEL, 1913, Text-book of paleontology, p. 319.

TWENHOFEL and SCHROCK, 1935, Text book of invertebrate paleontology, p. 233.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 540–545, PL. 92, NOVEMBER, 1944

FOSSILIFEROUS ORDOVICIAN IN LOWLANDS OF EASTERN PERU[1]

NORMAN D. NEWELL AND ISAAC TAFUR
Cuerpo de Ingenieros de Minas del Perú, Lima

ABSTRACT—A new area of Ordovician rocks has been discovered in the lowland area of northeastern Peru. A graptolite fauna of Middle Ordovician age, from the Contaya Hills east of the Ucayali River, is of extraordinary interest for the light it sheds on the regional structure and stratigraphy. The fauna is related to the zone of *Didymograptus murchisoni*, upper Llanvirnian, lower Chazyian, and clearly corresponds to similar faunas of southern Peru and northern Bolivia.

THE HEAVILY forested lowlands of eastern Peru are still slightly known geologically, but interest in the area has reached a high level because of the discovery and successful development of the Ganzo Azul (Agua Caliente) oil field on the lower Pachitea. For this reason regional geological studies of eastern Peru are now being undertaken by the Peruvian Government. Current studies reveal that the geological structure and stratigraphy of the area east of the Cordillera is considerably more complex than has generally been supposed. Future development of the petroleum resources of eastern Peru will be greatly expedited by the gathering of detailed information on the regional geology, with special emphasis on sequence and distribution of rock formations, and their structure.

This paper is a preliminary report on fossils of Middle Ordovician age collected in 1942 by the Geological Commission of the Cuerpo de Ingenieros de Minas of Peru, consisting of Douglas Fyfe, Isaac Tafur, and Richard Vosburgh. The initial collection of fossils was made by Tafur. Discovery of Ordovician rocks east of the Andes, some 450 kilometers from the nearest Ordovician exposures thus far reported, is of great importance in the understanding of the petroleum geology of the region. The fossiliferous rocks, for which Fyfe suggests the name Contaya formation, consist of medium-gray, well-laminated argillaceous shales that have not been observably altered. They are exposed in a broad anticline known as the Contaya Hills not far from the Brazilian border east of the Ucayali River, about 75 kilometers northeast of Contamana, and 450 kilometers south-southwest of Iquitos, the locality being approximately at 74° 34′ W. and 7° 9′ S. The Contaya formation, estimated at 150 meters in thickness, is underlain by massive quartzite of unknown thickness and age. The quartzite is unfossiliferous and only the upper 50 meters were examined. Throughout the middle Andes graptolite shales of the Middle Ordovician are underlain by massive quartzites, generally referred also to the Middle and Lower Ordovician. The Contaya formation is overlain with apparent discordance of slight angularity by perhaps a thousand meters of sandstones and shales, mainly Mesozoic and Cenozoic in age. The details of the stratigraphic column will be described at a future date when further information is obtained.

The fossils found in the Ordovician shales belong to the graptolite facies so characteristic of the Middle Ordovician rocks of the Andes of Peru and Bolivia.[2] This newly discovered occurrence indicates that the graptolite shales were deposited over a much greater area than has been previously supposed. It now seems probable that graptolite shales of the Middle Ordovician underlie the entire lowland area of eastern Peru.

THE CONTAYA FAUNA

Our fauna from northeastern Peru contains the usual elements that characterize graptolite faunas of other regions. In addition to graptolites, among which the dominant forms are of the "tuning-fork" type,

[1] Published with permission of the Director.

[2] We express appreciation to Dr. G. Marshall Kay, Columbia University, for aid in securing papers on Ordovician stratigraphy and fossils. Dr. Carl O. Dunbar has loaned us pertinent literature from his personal library.

FIG. 1.—Known areas of graptolite shales of Middle Ordovician age in Peru and Bolivia.

there are a few species of trilobites, atremate brachiopods, a dalmanellid brachiopod, one ostracode, one bellerophontid, and indeterminate Bryozoa and orthoceratoid cephalopods. The following list includes all of the forms identified in this preliminary study:

Didymograptus cf. *D. murchisoni* (Beck)
Didymograptus murchisoni geminus (Hisinger)
Glossograptus exiguus Bulman
Amplexograptus cf. *A. confertus* Lapworth
Ogygiocaris cf. *O. buchi* (Brongniart)
Trinucleus? nordenskiöldi Bulman
Triarthrus cf. *T. eatoni* (Hall)
Lingula sp.
Obolus cf. *O. fimbriatus* Hadding
Schizocrania aff. *S. filosa* (Hall)
Dalmanella sp.
Tetranota sp.
Tetradella sp.
Bryozoa, indet.
Orthoceracones, indet.

Nearly all of the fossils are preserved as molds, and due to compaction of the enclosing shales the graptolites are in every case flattened. The faunal assemblage is like the upper Llanvirnian faunas of south-

ern Peru and northern Bolivia, now well known through the works of Bulman (1931, 1933). Evidently the fauna belongs to the zone of *Didymograptus murchisoni*, equivalent in age to the lower Chazyian (Normanskill), Middle Ordovician of eastern North America.

ORDOVICIAN OF THE MIDDLE ANDES

Compared with their great spread in North America, Ordovician rocks are relatively restricted in South America, but they do reach impressive development in the Andean geosyncline.[4] Scattered occurrences of Ordovician rocks have been reported from Venezuela and Colombia. They are somewhat better known in Peru and Bolivia from the works of Steinmann (1929, 1930), and Steinmann and Hoek (1912). Important observations of the Ordovician in the southern part of the Cordillera are summarized by Gerth (1932) and by Harrington (1938).

From published records it appears that Ordovician rocks occupy discontinuous narrow bands along the eastern margin of the Andes from Venezuela well into Argentina. Unfortunately the greater part of the reports, particularly those contributions published prior to 1930 are characterized by a paucity of information about thickness and sequence of sections in specific localities. Even the excellent reports on the fossils from the Titicaca area are somewhat vague due to lack of detailed information as to the exact sequence of fossil zones in specific stratigraphic sections.

The Ordovician of the middle Andes is characterized by the broad distribution of the graptolite facies, and Bulman (1931) has shown that many zones of the world standard sequence are represented. The greatest development of graptolites occurs in argillaceous shales of the Middle Ordovician, equivalent in age to the Llanvirnian and Llandeilian stages of the type section in Britain. Including the newly discovered Contaya formation, graptolite shales of the Middle Ordovician are known at scattered localities extending from northeastern Peru to southern Bolivia. The similarity of the fossil faunas indicates that these formations were deposited in a continuous depositional trough.

The occurrence herein reported is the

TABLE OF GRAPTOLITE ZONES OF THE ORDOVICIAN[3]

Stages (European)	Zones	Stages (North American)
Ashgillian	*Dicellograptus anceps*	Cincinnatian
Caradocian	*Pleurograptus linearis* *Dicranograptus clingani*	Mohawkian
"Passage Beds"	*Mesograptus multidens* *Amplexograptus arctus*	
Llandeilian	*Nemalograptus gracilis* *Glyptograptus teretiusculus*	Chazyian (Normanskill)
Llanvirnian	*Didymograptus murchisoni* *Didymograptus bifidus*	
Arenigian	*Didymograptus hirundo* *Didymograptus extensus*	Canadian (Deepkill)

[3] Compiled from Elles, 1937, and from information supplied by Dr. G. Marshall Kay, Columbia University. Some European workers regard the entire Llanvirnian as equivalent in age to the upper part of the Deepkill graptolite facies of eastern North America.

[4] Possibly it is this somewhat limited distribution of Ordovician rocks in the southern continent, as well as the influence of the German school of geologists which have lead to a provincial adherence to the 19th century classification of the Ordovician and Gotlandian rocks in a single system—the Silurian. To the majority of English-speaking geologists in both hemispheres the prevalent usage in South America appears archaic.

northernmost exposure in Peru of the graptolite facies thus far recorded. Ordovician rocks are well developed, and well exposed in the Province of Huanuco, central Peru, near Cochachinche, in the Chaupihuaranca valley. Steinmann (1929, p. 17) discovered graptolites there in light-gray shales. The following fauna, thought by Steinmann and Ruedemann to represent early Llandeilian (Normanskill) was recognized:

Didymograptus sagitticaulis Gurley
Didymograptus serratulus Hall
Climacograptus tubuliferus Lapworth
Climacograptus ruedemanni Steinmann
Diplograptus cf. *D. foliaceus* Murchison
Glossograptus ciliatus Emmons
Dictyonema sp.
Ptilograptus sp.
Mastigiograptus sp.
Lingula cf. *L. attenuata* Sowerby

Probably this fauna is slightly younger than the Contaya fauna since it contains elements characteristic of zones higher than the zone of *Didymograptus murchisoni*. Judging from the figures published by Steinmann (1929, p. 18) as *C. tubuliferus* and *C. ruedemanni* these species may be representatives of *Amplexograptus*. The fragmentary character of the figured specimens of *Didymograptus* prevents satisfactory identification and comparison with our specimens.

In southern Peru graptolite shales of the Middle Ordovician are widely distributed. However, there are many areas of early Paleozoic rocks between the Chaupihuaranca area and the southern exposures that have not yet yielded graptolites, even where subjected to careful search (Harrison, 1940, p. 32). Graptolite-bearing shales extend through a considerable part of the Ordovician in the northern part of the Department of Puno, in the area north of Lake Titicaca. A collection taken by Douglas (1921, p. 50) in this area along the Chaquimayo River, studied by Lapworth, and again by Bulman (1931, p. 7), represents upper Llanvirnian. According to Bulman the Chaquimayo fauna includes:

Didymograptus stabilis Elles and Wood
Dicymograptus artus Elles and Wood
Didymograptus aff. *D. sagitticaulis* Gurley
Trichograptus? balstoni Lapworth
Glyptograptus cf. *G. angustifolius* (Hall)
Loganograptus logani boliviensis Bulman
Phyllograptus angustifolius Hall
Glossograptus cf. *G. holmi* Bulman
Glossograptus ciliatus douglasi Lapworth
Cryptograptus polyodus Lapworth
Amplexograptus coelatus Lapworth?

Bulman (1931) has concluded that at least two zones are included in the fauna, the zone of *D. murchisoni*, and a higher one. Thus the Chaquimayo fauna is partly equivalent in age to the Contaya fauna.

Graptolites and other fossils collected in the Department of Puno, along the Bolivian border, by Nordenskiöld and described by Bulman (1931) are closely comparable with the Contaya fauna. Several collections taken between Limpucuni and Locheta in the vicinity of Juan del Oro contain the following upper Llanvirnian species:

Didymograptus murchisoni geminus (Hisinger)
Didymograptus aff. *D. amplus* Elles and Wood
Didymograptus stabilis Elles and Wood
Didymograptus miserabilis Bulman
Didymograptus cf. *D. euodus* Lapworth
Cryptograptus tricornis schaeferi Lapworth
Amplexograptus coelatus Lapworth?
Amplexograptus cf. *A. confertus* Lapworth
Amplexograptus latus Bulman
Glossograptus exiguus Bulman
Glyptograptus dentatus (Brongniart) mut.
Diplograptus priscus (Elles and Wood)?
Trinucleus nordenskiöldi Bulman

Another fauna was obtained in the same area, near the Quitari, a tributary of the Susiniscato River, and was studied by Bulman (1933). According to him this fauna is of upper and/or middle Llanvirnian, and therefore is also equivalent in age to the Contaya fauna. The following species were recognized:

Didymograptus murchisoni geminus (Hisinger)
Didymograptus stabilis Elles and Wood
Didymograptus climacograptoides Holm
Didymograptus aff. D. *euodus* Lapworth
Dichograptidae
Dicellograptus sp.
Glyptograptus dentatus (Brongniart) mut.
Amplexograptus perexcavatus (Lapworth) var.
Cryptograptus schaeferi (Lapworth)
Cryptograptus schaeferi latus Bulman
Leptobolus insignis mut. *latus* Ruedemann
Schizocrania aff. *S. filosa* (Hall)
Homotelus sp.
Asaphus sp.
Triarthrus sp.
Trinucleus sp.

Numerous localities in Bolovia have yielded graptolite faunas of similar or identi-

cal age with the Contaya fauna. Bulman (1931) has described several collections obtained by Nordenskiöld from the Korpa and Mojos districts in northern Bolivia. These are like the graptolite faunas of upper Llanvirnian age from southern Peru. In the same general area of Bolivia Evans (1903) collected graptolites from Caupolican, along the Rio Pelechuco, which were studied by Wood (1906). The fossils apparently represent a horizon somewhat lower than the Contaya fauna, in the zone of *Didymograptus bifidus* (lower Llanvirnian).

Graptolites have also been reported from central and southern Bolivia, and from Argentina, but the occurrences are not at all well known. These have been summarized by Bulman (1931) and do not require further attention here. In general, it appears that the graptolite facies of the Middle Ordovician gradually gives way across central and southern Bolivia to sandy and limy beds in which graptolites are rare or absent.

REFERENCES

BULMAN, OLIVER M. B., 1931, South American graptolites, with special reference to the Nordenskiöld collection: Archiv for Zoologi, K. Svenska Vetenskapsakademien, Band 22A, no. 3, 111 pp. 12 pls.

BULMAN, OLIVER M. B., 1933, Report on the graptolites from the Quitari area: Geol. Soc. London Jour., vol. 89, pp. 308–348.

DOUGLAS, JAMES A., 1920, Geological sections through the Andes of Peru and Bolivia, II, From the port of Mollendo to the Inambari River: idem, vol. 76, pp. 1–59.

ELLES, GERTRUDE L., 1937, The classification of the Ordovician rocks; The Geological Mag., vol. 74, pp. 481–495.

ELLES, GERTRUDE L., and WOOD, E. M. R., 1901–1908, A monograph of British graptolites: Palaeontographical Soc., London, in 7 parts.

GERTH, H., 1932, Geologie Sudamerikas: Geologie der Erde, pt. 1, pp. 82–105.

EXPLANATION OF PLATE 92

Figures ×2, except those otherwise indicated.

FIGS. *1*—*Dalmanella* sp. Plastellene cast of a natural mold. The species is rare in our collections, and all of the ventral valves are very small juveniles. Contaya formation, Contaya Hills, northeast of Contamana, Department of Loretto, Peru.

2–4—*Ogygiocaris* cf. *O. buchi* (Brongniart). Three artificial casts of plastellene, tentatively referred to a well-known Middle Ordovician species. Fragmentary material indicates that some individuals attained approximately twice the size of the figured specimens. Same locality.

5—*Lingula* sp. Photograph of largest individual obtained. Same locality as above.

6—*Trinucleus? nordenskiöldi* Bulman. Typical representative, fragmentary cephalon, showing typical ornamentation and form of the species. As pointed out by Whittington (1941, p. 26) this species does not correspond to any of the thirteen described genera of Trinucleidae. Further collections in the future may yield adequate material for satisfactory generic diagnosis. Same locality.

7—*Triarthrus* cf. *T. eatoni* (Hall). Fragmentary cranidium referred to the well-known Middle Ordovician species with some hesitancy because of the incompleteness of our material. Very rare in the Contaya formation.

8—Trilobite cranidium, gen. and sp. indet. Drawing of a crushed, but otherwise well-preserved specimen. Rare in the Contaya formation.

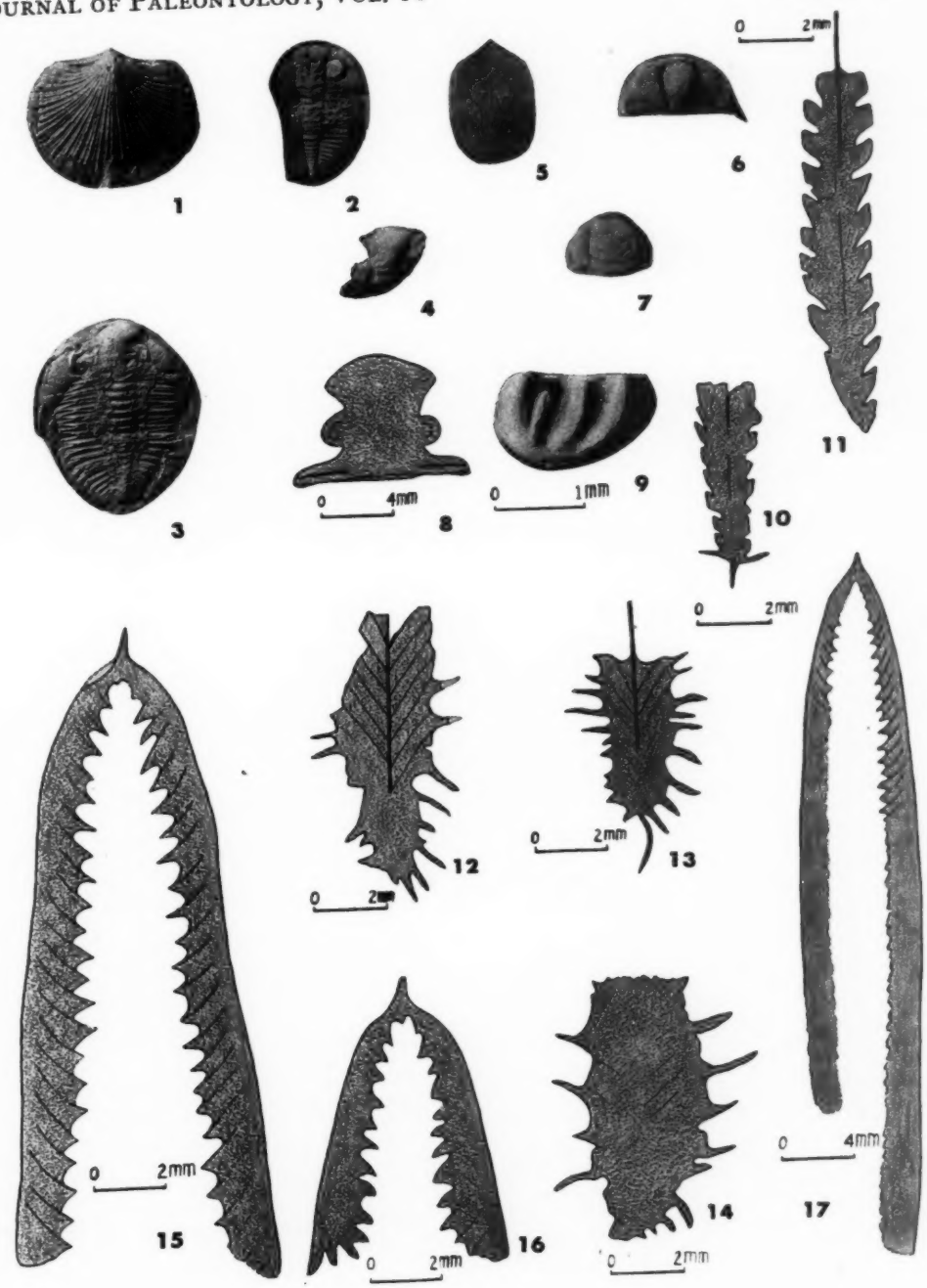
9—*Tetradella* sp. Internal mold ("cast") of an ostracode which is quite abundant in our collection from the Contaya formation.

10–11—*Amplexograptus* cf. *A. confertus* Lapworth. Very common in the Contaya formation. This form is identical with that described under the same name by Bulman (1931, p. 60) from southern Peru and northern Bolivia. It is characterized by somewhat wide apertural excavations, and rather abrupt initial widening of the rhabdosome, in this respect resembling *A. perexcavatus* (Lapworth).

12–14—*Glossograptus exiguus* Bulman. A common species in the Contaya formation. Characterized by its small size and rather widely spaced thecae, otherwise being similar to the geologically younger *G. hincksii*. All of our material is fragmentary.

15–16—*Didymograptus murchisoni geminus* (Hisinger). The commonest graptolite in our collections. Characterized by having a relatively narrow proximal end, rapidly widening stipes which are of uniform width for the greater part of their length. The majority of our specimens are juveniles, like *16*.

17—*Didymograptus murchisoni* (Beck)? A rare individual somewhat questionably referred to the well-known zone fossil, because of the imperfections of the specimen.



Newell and Tafur – Ordovician of Peru

UNIV. OF MICH.

HARRINGTON, HORACIO J., 1938, Las faunas del Ordovicico Inferior del norte de la Argentina: Revista del Museo de La Plata, Tomo 1, Sec. Paleont. pp. 109–289.

HARRISON, J. V., 1940, Nota preliminar sobre la geología de los Andes centrales del Peru: Soc. Geol. Peru Bol., Tomo 10, pp. 1–52.

LAKE, PHILIP, 1906, Trilobites from Bolivia, collected by Dr. J. W. Evans in 1901–1902: Geol. Soc. London Quart. Jour., vol. 62, pp. 435–440.

STEINMANN, G., 1929, Geologie von Peru, 448 pp., Heidelberg. A Spanish language translation was published in 1930.

STEINMANN, G., and HOEK, H., 1912, Das Silur und Kambrium des Hochlandes von Bolivia und ihre Fauna: Neues Jahrb. f. Min., Beilage-Band 34, pp. 176–252.

WHITTINGTON, HARRY B., 1941, The Trinucleidae, with special reference to North American genera and species: Jour. Paleontology, vol. 15, pp. 21–41.

WOOD, E. M. R., 1906, On graptolites from Bolivia, collected by Dr. J. W. Evans in 1901–1902: Geol. Soc. London Quart. Jour., vol.62, pp. 431–432.

MANUSCRIPT RECEIVED APRIL 27, 1943.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 546–549, NOVEMBER 1944

A NEW PALEOCENE CATOMETOPE CRAB FROM TEXAS, TEHUACANA TEHUACANA

H. B. STENZEL
Bureau of Economic Geology, Austin, Texas

THE SQUARE-FRONTED or catometope crabs are a loosely combined group which usually have a carapace of squarish outline. However, the group is ill defined as a whole and not sharply separated from the cyclometope or round-fronted crabs. The family Goneplacidae in particular is a link between the two groups and perhaps it will be found to include the ancestors of the catometope crabs. In this respect, the new genus described below is of interest, because it is a very ancient goneplacid of Paleocene age. At the present, however, the knowledge of fossil crabs is so limited that it is premature to trace their evolution in detail. Before this can be done, many more fossils must be collected, prepared, and described in minute detail.

Tribe BRACHYURA Latreille
Subtribe BRACHYGNATHA Borradaile
Family GONEPLACIDAE Dana
Genus TEHUACANA H. B. Stenzel, n.g.

Genotype. *Tehuacana tehuacana* Stenzel, n. sp., from the Midway group (Paleocene) of Texas.

Generic description.—Carapace squarish in outline, highly arched in transverse as well as in longitudinal direction; width of front medium, one-third the width of carapace; antero-lateral margin short, convex, with 4 blunt teeth; posterolateral margins nearly straight, convergent; posterior margin emarginate for last pair of ambulatory legs. Orbits medium-sized, far apart, well-enclosed; frontoorbital width two-thirds carapace width. Orbital hiatus narrow, closed by the antenna. Areolation of carapace well developed, particularly strong on posterior part. Antennules fold beneath front in transverse direction; interantennular septum thin. Buccal cavern square, with narrow raised rim in front. Sternum small, fifth somite almost entirely hidden by abdomen in male.

Remarks.—This new genus seems closely related to *Pilumnoplax* Stimpson.[1] However, *Tehuacana* has a more arched carapace, very much deeper grooves, and better separated regions on the carapace. The arrangement of the regions is somewhat different in the two genera; the anterior regions occupy more space on the carapace of *Pilumnoplax* than of *Tehuacana;* as a consequence the mesogastric and mesobranchial regions of *Pilumnoplax* are nearer the posterior than the anterior end of the carapace, whereas in *Tehuacana* they are nearer the anterior end. The width of the front between the orbits is larger in *Pilumnoplax* than in *Tehuacana*. The anterolateral dents in *Pilumnoplax* are much sharper and more protruding than in *Tehuacana*.

The name proposed for this new genus is the name of the Indians who once inhabited the region near the type locality.

TEHUACANA TEHUACANA
Stenzel, n. sp.
Plate 93, figures 6–9; text figures 1–3

Description.—Carapace small, squarish in outline, highly arched. Front broken back to epigastric region in holotype; width one-third the carapace width. Orbits wider than high, in ratio of 3 to 2, slightly contracted in middle, well enclosed; upper orbital margin with 2 shallow, rounded emarginations, one in the middle, other at outer end adjoining outer orbital dent. The latter is stout and blunt. Lower orbital margin with narrow orbital hiatus occupied by antenna; remainder of lower orbital margin without fissures, leads in a smooth concave curve from projecting point at orbital hiatus to outer orbital dent. Anterolateral margin short, convex, bluntly angulated in

[1] Stimpson, W., 1858, Prodromus descriptionis animalium evertebratorum, quae in Expeditione ad Oceanum Pacificum Septemtrionalem, A republica Federata missa, Cadwaladaro Ringgold et Johanne Rodgers Ducibus, observavit et descripsit, Pars V, Crustacea ocypodoidea: Acad. Nat. Sci. Philadelphia Proc., vol. 10, p. 93. Genotype: *P. sulcatifrons* Stimpson.

cross section, with 4 blunt dents, first is outer orbital, last is branchial. Width of carapace greatest at third and fourth anterolateral dents. Posterolateral margin slightly longer than anterolateral, very slightly convex, bluntly and indistinctly angulated in cross section, less defined than anterolateral margin, convergent posteriorly. Posterior carapace margin wide, about two-thirds width of carapace, edge slightly thickened, consisting of 3 parts, pair of emarginations—presumably occupied by last pair of legs—and wider, slightly concave median part.

Areolations well developed, particularly on posterior slope. Protogastric areolation large, flat-topped, roughly pentagonal in outline connecting with slightly higher epigastric swellings. Meso- and metagastric areolations united into pentagonal outline; median anterior extension long, very narrow; posterior slope steepened, granulated. Hepatic areolation small, flat-topped, extending into second anterolateral dent, separated by very obscure, shallow groove from orbital region and dent. Cardiac areolation wider than long, pentagonal in outline, high, round-topped with steep slopes;

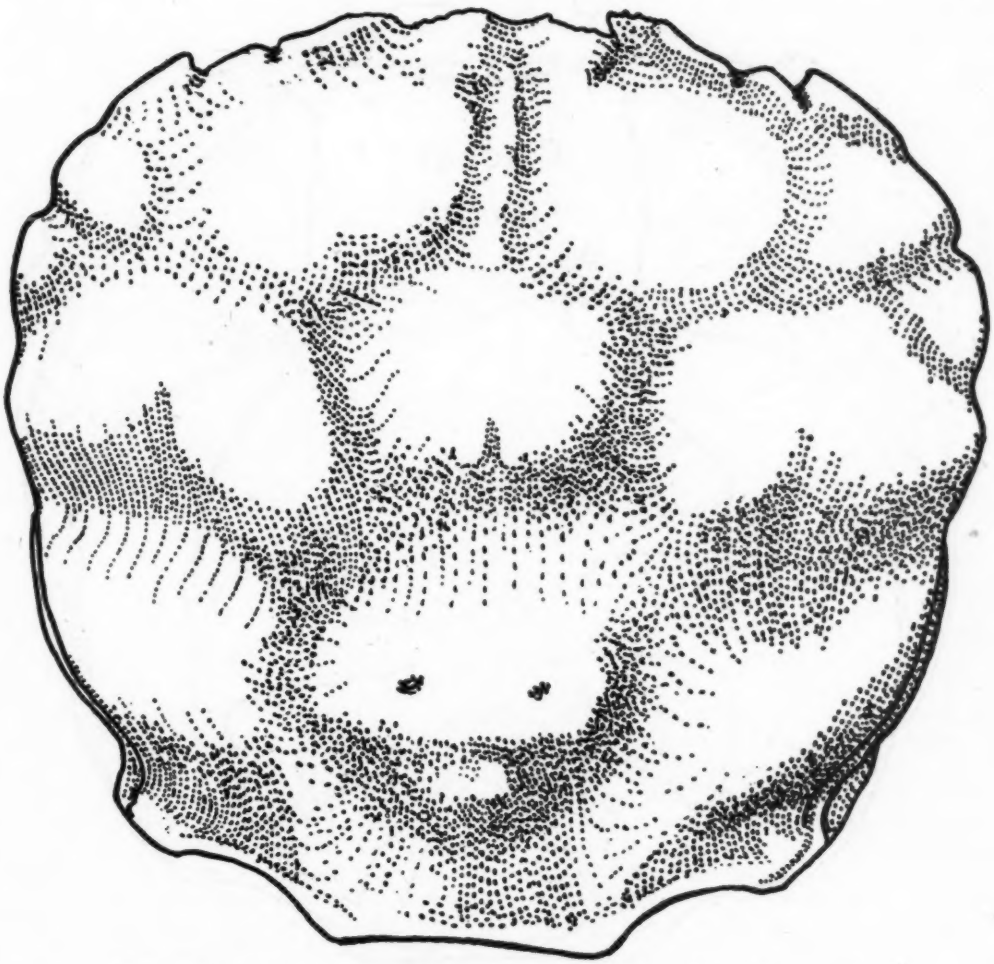


FIG. 1. Dorsal view of carapace, *Tehuacana tehuacana* Stenzel, monotype, ×9.

two tubercles form transverse row on top; a steeply sloping, rounded median ridge extends posteriorly from cardiac areolation, has slight hump, disappears before reaching margin. Metabranchial areolation small, swelling transversely elongate, extending to fourth anterolateral tooth. Third anterolateral tooth has small low, flat-topped aerolation adjoining it; latter separated from hepatic and epibrachial swellings by

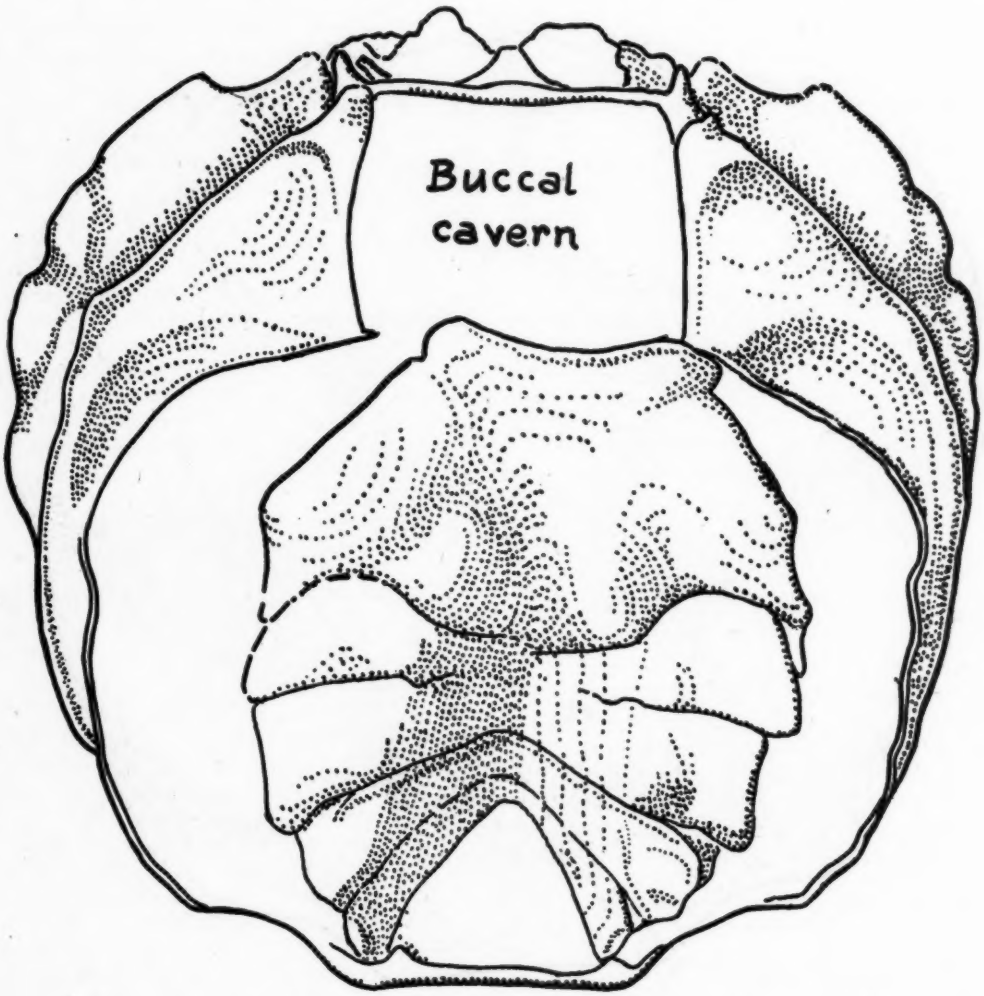


FIG. 2. Ventral view of carapace, *Tehuacana tehuacana* Stenzel, monotype, ×9.

wider than long, well separated by broad and deep groove from other branchial swellings, with rounded high swelling at inner end. Mesobranchial and epibranchial areolations united, except for notch on their posterior slope indicating separation; mesobranchial swelling rounded; epibranchial well-marked, but shallow, grooves. Grooves separating various swellings deep and wide in posterior, narrow and shallow in anterior part of carapace.

Antennules transverse, separated by thin wall. Buccal cavity large, square.

Sternum small, longer than wide, with

deep median trench for placement of abdomen indicating that holotype is male. Only a small, triangular part of fourth somite remained outside trench and was therefore presumably not covered by the male abdomen. Only a tiny posterior corner of fifth somite is outside trench; therefore all except that corner was covered by the male abdomen.

Dimensions.—Length 14.5 mm., width 15.1 mm., width of front 4.7 mm., fronto-orbital width 9.6 mm., width of buccal cavity 5.3 mm.

Holotype.—Bureau of Economic Geology, The University of Texas, Austin.

Type locality.—Tehuacana Creek, about 1 mile southwest of the crossing of the Houston and Texas Central Railroad, about 3½ to 4 miles south of Wortham, Limestone County, Texas. Presumably at or very near U. S. Geological Survey station 10846.[2]

Geologic horizon.—Wills Point formation, Midway group, Paleocene. The following fossils were collected at the same place.

Flabellum conoideum Vaughan
Trochocyathus uber Vaughan and Popenoe
Caryophylliadumblei Vaughanand Popenoe
Balanophyllia ponderosa texana Vaughan and Popenoe
Cucullaea macrodonta Whitfield

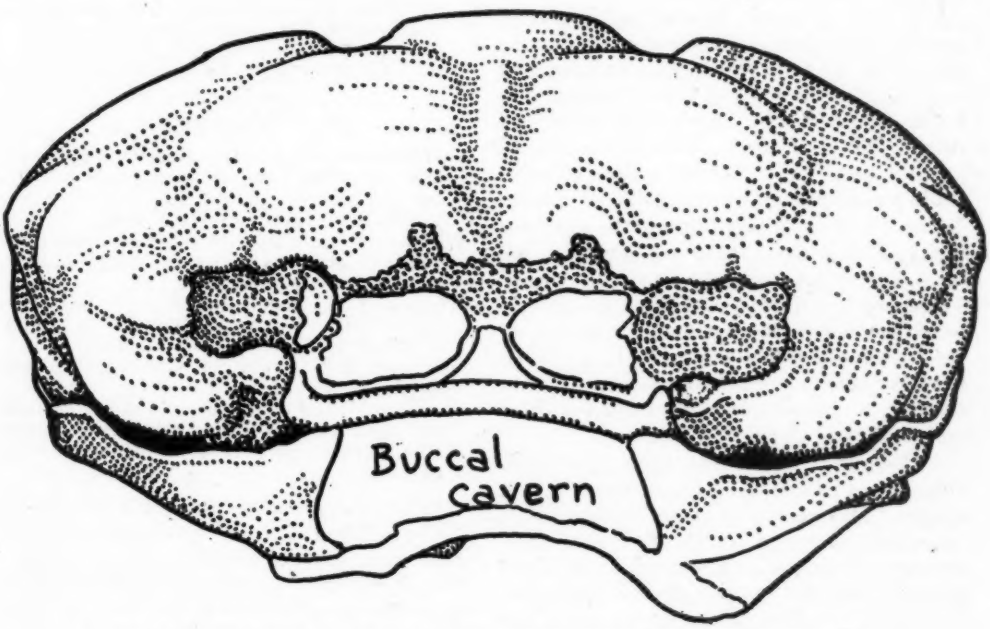


FIG. 3. Frontal view of carapace, *Tehuacana tehuacana* Stenzel, monotype, ×9.

[2] Gardner, Julia, The Midway group of Texas: Texas Univ. Bull. 3301, p. 102, 1933 [1935].

PUBLISHED BY PERMISSION OF THE DIRECTOR, BUREAU OF ECONOMIC GEOLOGY, THE UNIVERSITY OF TEXAS. MANUSCRIPT RECEIVED AUGUST 22, 1943.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 550–552, PL. 93, NOVEMBER 1944

A NEW CRETACEOUS CRAB, GRAPTOCARCINUS MUIRI, FROM MEXICO

H. B. STENZEL
Bureau of Economic Geology, Austin, Texas

THE FOSSIL crab genus *Graptocarcinus* Roemer is poorly represented in species as well as specimens. The first species of the genus, *Gr. texanus* Roemer,[1] was described in 1887. It occurs in the lower Cenomanian Buda limestone in the neighborhood of Austin, Travis County, Texas. The species has not been found as yet in the extensive Buda limestone outcrops outside of central Texas. Even in Travis County the crab is a rarity. Fortunately there are several topotype specimens available to the writer. These were collected and later generously contributed by that assiduous collector of the Comanche Cretaceous, Dr. F. L. Whitney. For convenience of comparison, *Graptocarcinus texanus* Roemer has been described and refigured below.

Rathbun[2] recorded the genus from the Oligocene of Oregon as *Graptocarcinus* (*?*), species. This specimen is an unidentifiable fragment, to judge by the figure. *Graptocarcinus* is a primitive Cretaceous genus and probably did not survive to the Oligocene. Rathbun's citation of the genus should be dropped because of its great uncertainty.

Graptocarcinus muiri is the second known species of the genus. It extends the geographical range of the genus from central Texas to northeastern Mexico and the stratigraphic range from lower Cenomanian to Albian.

Tribe BRACHYURA
Subtribe DROMIACEA de Haan
Superfamily DROMIIDEA Alcock
Family DYNOMENIDAE Ortmann
Genus GRAPTOCARCINUS Ferdinand von Roemer, 1887

Graptocarcinus texanus, ein Brachyure aus der oberen Kreide von Texas: Neues Jahrb., Band 1, pp. 173–176, text fig., 1887.

[1] Roemer, Ferdinand von, *Graptocarcinus texanus*, ein Brachyure aus der oberen Kreide von Texas: Neues Jahrb., Band 1, pp. 173–176, text fig., 1887.

[2] Rathbun, M. J., 1926, The fossil stalk-eyed Crustacea of the Pacific slope of North America: U. S. Nat. Mus. Bull. 138, pp. 4, 6, 17, 88–89, 144, pl. 21, fig. 3.

Genotype, *Graptocarcinus texanus* Roemer from the lower Cenomanian Buda limestone of central Texas. Genotype by monotypy.

GRAPTOCARCINUS TEXANUS
von Roemer
Plate 93, figures 1, 2

Graptocarcinus texanus von Roemer, Ferdinand, 1887, *Graptocarcinus Texanus*, ein Brachyure aus der oberen Kreide von Texas: Neues Jahrb., Band 1, pp. 173–176, text fig.

Whitney, F. L., Fauna of the Buda limestone: Univ. Texas Bull. 184 (Sci. Ser. 18), pp. 27–28, pl. 13, figs. 1, 2 [not 3], 1911.

Whitney, F. L., Fauna of the Buda limestone: Texas Acad. Sci. Trans., vol. 12, pt. 1, pp. 27–28, pl. 13, figs. 1, 2 [not 3], 1913.

Glaessner, M. F., Crustacea decapoda: Fossilium Catalogus I, pt. 41, p. 203, 1929.

Rathbun, M. J., Fossil Crustacea of the Atlantic and Gulf Coastal Plain: Geol. Soc. Amer., Spec. Paper 2, pp. 4, 9, 41, pl. 10, figs. 13–15, 1935.

Original description (*translated and edited*) —Cephalothorax transverse-oval, one-fifth wider than long, of rounded pentagonal outline. A fine, raised, sharp, encircling margin separates dorsal from ventral surface. Dorsal surface moderately convex; flattening in the center. Front curves strongly down at the anterior and ends in a broad, obtusely pointed rostrum divided by a fine longitudinal groove in middle and with raised margins. Deeply emarginate orbits immediately adjoin the rostrum.

Entire surface of cephalothorax coarsely and densely granulate. Between the coarse grains or warts a few smaller granules are scattered. Wherever the warts are broken off at the tip they seem ring-shaped and somewhat deepened in the center.

Two pairs of converging grooves present on gently convex central surface of cephalothorax. Anterior pair longer and stronger, slightly curved inward and converging at obtuse angle of about 130 degrees. Grooves deeper and broader at their distal ends, becoming weaker proximally with junction barely visible and ends apparently not joining in some specimens. Posterior pair shorter and weaker, at first nearly parallel

to the anterior pair, but later bending suddenly back at an angle and simultaneously becoming weak, indistinct, and barely traceable. Surface of cephalothorax uniformly convex and devoid of any other sculpture. Characteristically without swellings corresponding to the various internal organs such as are more or less distinct in nearly all brachyuran genera. Neither the cardiac, gastric nor branchial region seems outlined in any way. Anterior pair of grooves is probably an indication of the cervical grooves which delimit the gastric region posteriorly and which are present in most Brachyura.

Ventral surface of cephalothorax obliquely bent inward and nearly smooth; finely granulate only toward front and posterior. Opposite anterior pair of dorsal grooves is a fine notch in the sharp margin separating dorsal and ventral surface which passes forward as a linear, fine groove in a flat arc.

Addition to description.—The grooves were well described by Roemer. New material, however, shows that the fine median groove of the rostrum splits upon leaving the posterior end of the rostrum and encloses a very acute angle. There are also 3 pairs of pits on the carapace (see pl. 93, fig. 2). One pit (paired) lies near the distal end of the cervical groove, about 2 mm. forward and inward from its end and forming a right angle. The other 2 pits (paired) are about halfway between the center and the lateral extremity of the carapace on a line connecting the two lateral extremities of the carapace.

A pair of fairly large epigastric swellings lies between the orbits at the posterior end of the rostrum. They are transverse in outline, confluent at the midline and the fine median groove of the rostrum passes over their junction and splits forming two grooves immediately posterior of the swellings.

The shape of the eyes is incorrect in Roemer's sketch; they are wider and less high than shown by him.

Type specimens.—Roemer's four types are presumably at the Geological Institute of either the University of Bonn or Breslau, Germany. Topotypes in U. S. National Museum, Washington, D. C.; Bureau of Economic Geology, The University of Texas, Austin; Musée royal d'Histoire naturelle de Belgique, Brussels, Belgium.

Type locality.—Shoal Creek in northwestern part of Austin, Travis County, Texas.

Geologic horizon.—Buda limestone of Comanche series, Cretaceous (lower Cenomanian).

Distribution.—Found also in Buda limestone of Barton Creek in southwestern part of Austin and in first creek south of Manchaca, Travis County, Texas, and along Blanco River, Hays County, Texas.

GRAPTOCARCINUS MUIRI
Stenzel, n. sp.
Plate 93, figures 3–5

Description.—Carapace small, transversely oval in outline, one-third to one-fourth wider than long; greatest width posterior to center; lateral extremity rounded in outline; nearly flat in middle, sloping away steeply in all directions. Frontal rostrum obtusely pointed, descending steeply, divided by short and shallow median groove. Orbits narrow and long, each about 1 by 3 mm. in size; outer or lateral end of orbit above inner end of anterolateral margin. Rim of frontal rostrum, orbits, anterolateral edge, and posterior edge with a simple, smooth, raised margin. In front this margin extends to the lateral extremity of carapace but disappears upon entering the posterolateral edge. Posterolateral edge thickly rounded to obtusely angulated. Adjoining the raised margin is a shallow groove free of larger tubercles along the rim of the frontal rostrum and orbits and along posterior edge, but not along the anterolateral margins.

Surface of carapace uniformly covered with tubercles and smaller granules. Paired grooves in middle portion of carapace very poorly preserved; only anterior pair recognizable, apparently similar to that of *G. texanus* Roemer.

Subbranchial region of ventral surface of carapace separated from subhepatic and pterygostomian region by narrow, shallow, curved groove which extends to raised margin of anterolateral edge and produces in it a very shallow notch. Surface of subhepatic and pterygostomian region covered with fine granules. Surface of subbranchial region

covered with small granules in the anterior portion, but posterior portion adjoining posterolateral edge, covered uniformly with fine granules and larger tubercles not quite as large as those on the dorsum.

Dimensions.—Length 17.7 mm., width 13.9 mm., fronto-orbital width 8.9 mm.

Remarks.—This species differs from *G. texanus* Roemer only in minor, but evidently specific, details. *G. muiri* is one-half or less the size of *G. texanus;* it is also proportionately shorter and wider, the proportions of width to length being about 1.13:1 in *G. texanus* and 1.28:1 in *G. muiri.*

The raised margin of the carapace is simple and smooth in *G. muiri,* but in *G. texanus* it is studded with tubercles and granules similar to those of the dorsal surface. The groove adjoining this raised margin is free of larger tubercles in *G. muiri;* the same groove is present in *G. texanus* but it is very inconspicuous because it is not free of tubercles. The raised margin of *G. muiri* is not continuous around the entire edge of the carapace, being absent along the posterolateral edges; but in *G. texanus* the raised and tubercle carrying margin encircles the carapace completely.

Holotype.—Bureau of Economic Geology, University of Texas, Austin.

Type locality.—Choy Cave in Sierra del Abra between Las Palmas and Taninúl, at kilometre 550 on the railroad between Tampico and San Luis Potosí, State of San Luis Potosí, Mexico.

Geologic horizon.—Taninúl limestone, Cretaceous (Albian). The Taninúl limestone, according to Adkins,[3] contains at Choy Cave the following additional fossils:

Eoradiolites aff. *E. quadratus* Adkins
Caprinula sp.
Chondrodonta cfr. *C. munsoni*
Gastropods
Pelecypods
Corals

This is a classic Mexican stratigraphic locality and has been mentioned by several authors.[4] Muir's comprehensive summary is the latest description.

The holotype was collected by the late John M. Muir, outstanding expert on the geology of Mexico. His work on the geology of the Tampico region is especially important to paleontologists for his accurate account of type localities of fossils. *Graptocarcinus muiri* is named in his honor and to commemorate the many discussions of the geology of Mexico which were held at the Bureau of Economic Geology by John M. Muir and W. S. Adkins, C. L. Baker, J. B. Dorr, and the writer at the time Muir was writing his report.

[3] Adkins. W. S., 1930. New rudistids from the Texas and Mexican Cretaceous: Texas Univ. Bull. 3001, p. 82.

[4] Boehm, Georg, 1898. Ueber Caprinidenkalke aus Mexico: Deutsche geol. Gesell. Zeitschr., vol. 50, p. 325.

Boehm, Georg, 1899. Beitraege zur Kenntniss mexikanischer Caprinidenkalke, *in* Felix, J.. and Lenk, H., Beitraege zur Geologie und Paleontologie der Republik Mexico, pt. 2, pp. 143–154, Leipzig.

Burkhardt, C., 1930. Étude synthétique sur le Mésozoïque mexicain: Soc. Paléont. Suisse Mém., vols. 49–50, p. 192.

Muir, J. M., 1936. Geology of the Tampico region, Mexico, Amer. Assoc. Petr. Geol., pp. 36–38.

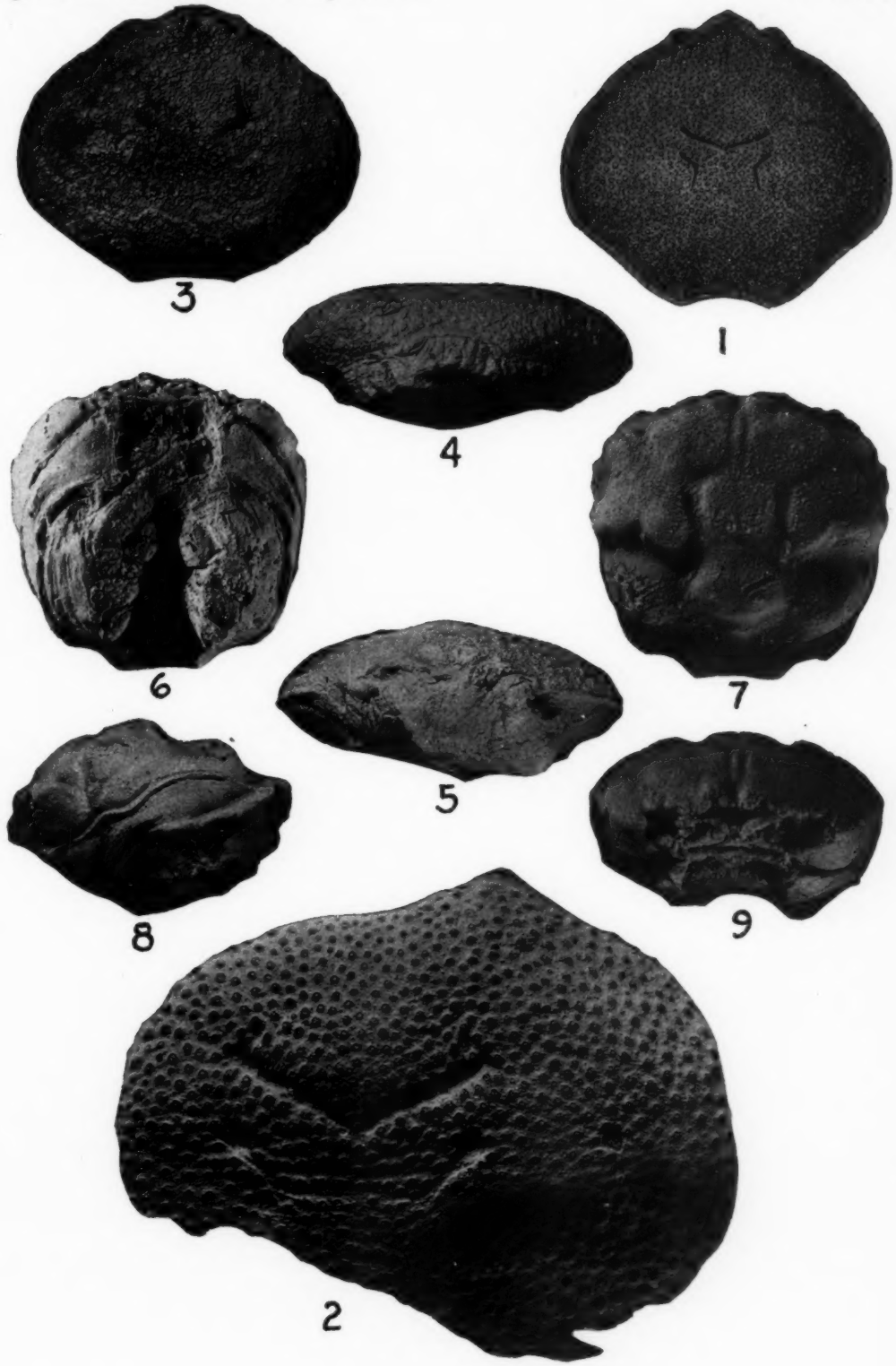
PUBLISHED BY PERMISSION OF THE DIRECTOR, BUREAU OF ECONOMIC GEOLOGY, THE UNIVERSITY OF TEXAS. MANUSCRIPT RECEIVED AUGUST 25, 1943.

EXPLANATION OF PLATE 93

FIGS. *1, 2*—*Graptocarcinus texanus* Roemer. *1,* Copy of original type figure, dorsal view of carapace, ×1. *2,* Surface sculpture of part of a carapace, topotype specimen, ×3. From Shoal Creek in northwestern Austin, Travis County, Texas; Buda limestone, Comanche series, Cretaceous (lower Cenomanian). (p. 550)

3–5—*Graptocarcinus muiri* Stenzel, n. sp., ×3. *3–5,* Dorsal, posterior, and frontal views of carapace, holotype. From Choy Cave in Sierra del Abra between Las Palmas and Taninúl, at kilometre 550 on the railroad between Tampico and San Luis Potosí, State of San Luis Potosí, Mexico; Taninúl limestone, Cretaceous (Albian). (p. 551)

6–9—*Tehuacana tehuacana* Stenzel, n. g., n. sp., ×3. *6–9,* Ventral, dorsal, left lateral, and frontal views of carapace, holotype. From Tehuacana Creek, about 1 mile southwest of the crossing of the Houston & Texas Central Railroad, about 3½ to 4 miles south of Wortham, Limestone County, Texas; Wills Point formation, Midway group, Paleocene. (p. 546)



Stenzel – Cretaceous Crab and Paleocene Crab

UNIV. OF MICH.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 553–557, NOVEMBER 1944

PALEOECOLOGY OF THREE FAUNULES IN THE PERMIAN KAIBAB FORMATION AT FLAGSTAFF, ARIZONA

DAVID NICOL
Stanford University, California

ABSTRACT—Three faunules from facies 3 of the Alpha member of the Permian Kaibab formation at Flagstaff, Arizona are analyzed. This study shows that pelecypods, particularly the genus *Schizodus*, are well adapted to these shallow, land-locked, and somewhat hypersaline seas. Some gastropod genera and a scaphopod could also stand the extreme conditions well, but brachiopods, which are very abundant in true marine conditions, did not find this environment favorable. Because of their erratic distribution, it seems plausible that bryozoa and nautiloids were swept into the sediments of the Alpha member of the Kaibab formation by waves or currents.

THE STUDY described in this paper is based on field and laboratory work done at the Museum of Northern Arizona at Flagstaff during the months of August and September, 1942. Work was restricted to facies 3 of the Alpha member, the upper 130 feet, of the Kaibab formation in an area extending from Flagstaff southward for a distance of 7 miles.

The Alpha member of the Kaibab formation contains, according to McKee (1938, p. 43), beds deposited in a retreating sea. West of the Flagstaff area strata of the Alpha member are of different facies, but supposedly of equivalent age, and contain gypsum and red beds. The composition of the fauna and the character of the sediments in facies 3 of the Alpha member indicate shallow water. The impoverished fauna does not suggest brackish water, although the environment was not typically marine. The land-locked basins may have been hypersaline as McKee (1938, p. 146) suggested for facies 1, 2, and 3 of the Alpha member.

The strata of facies 3 consist of thin-bedded dolomites, dolomitic sandstones, sandstones, and intraformational conglomerates (fig. 1). The beds of the lower part of the Alpha member grade into the more massive dolomites and sandstones of the Beta member. Where both members are exposed near Flagstaff a massive white sandstone marks the top of the Beta member.

Because of rapid changes in lithology, beds of the Alpha member cannot be traced more than a few miles. Fossiliferous beds are usually less resistant to erosion than non-fossiliferous ones, and fossils can easily be collected only in road cuts or similar fresh exposures.

The beds of the Alpha member become increasingly sandy toward the top. Dolomitic sandstones containing large rounded quartz grains are found at several horizons. A similar condition was mentioned by Newell (1940, p. 266) in the Permian Whitehorse sandstone of Oklahoma and Texas. From their rounded, pitted, and frosted appearance, one may surmise that the quartz grains were wind-blown and were transported seaward from dunes on shore.

Intraformational conglomerates are also found near the top of the Kaibab formation at this locality. They are made up of large angular fragments of dolomite and chert, mainly the former, and appear not to have been transported any appreciable distance before being reconsolidated.

Great difficulty was found in locating individual beds of the Kaibab formation at a definite number of feet below the Triassic Moenkopi formation because of the erosional unconformity between these formations. The amount of erosion of the Kaibab surface varies at least 20 feet within a few miles in this area.

Fossils are abundant in certain dolomites and sandy dolomites and are preserved as internal casts. McKee (1938, p. 53) described the occurrence of fossils in spherical pockets. The fossiliferous beds are not as a rule more than 5 feet thick nor can they, with one possible exception, be traced more than a mile laterally.

ECOLOGICAL TERMINOLOGY

The term faunule was introduced to paleontologists by H. S. Williams (1903, p. 6) but was subsequently restricted in meaning by Fenton and Fenton (1928, p. 15). In this paper it is used according to their definition:

> A faunule is an assemblage of animals dominated by one community or its representatives, but including organisms which, though found in that community, do not belong to it.

Specimens from the faunules collected for description in this paper came from beds or strata of both areal and vertical extent—zonules (Fenton and Fenton, 1928, p. 21).

Wasmund, working with Recent material, introduced the term thanatocoenosis (1926, p. 6). A thanatocoenosis is a collection of dead organisms, shifted together by waves, currents, wind, or other causes, and later buried. Because of alterations in the composition of communities after death of the organisms, faunules with which paleontologists deal are thanatocoenoses and not true biocoenoses.

When the assemblages of the faunule examined in this study are analyzed, it becomes evident that they are all thanatocoenoses and not biocoenoses. The best examples of changes of assemblages due to effects of waves or currents after the death of the animals are seen in the erratic occurrences of the Bryozoa and nautiloids in the Alpha member.

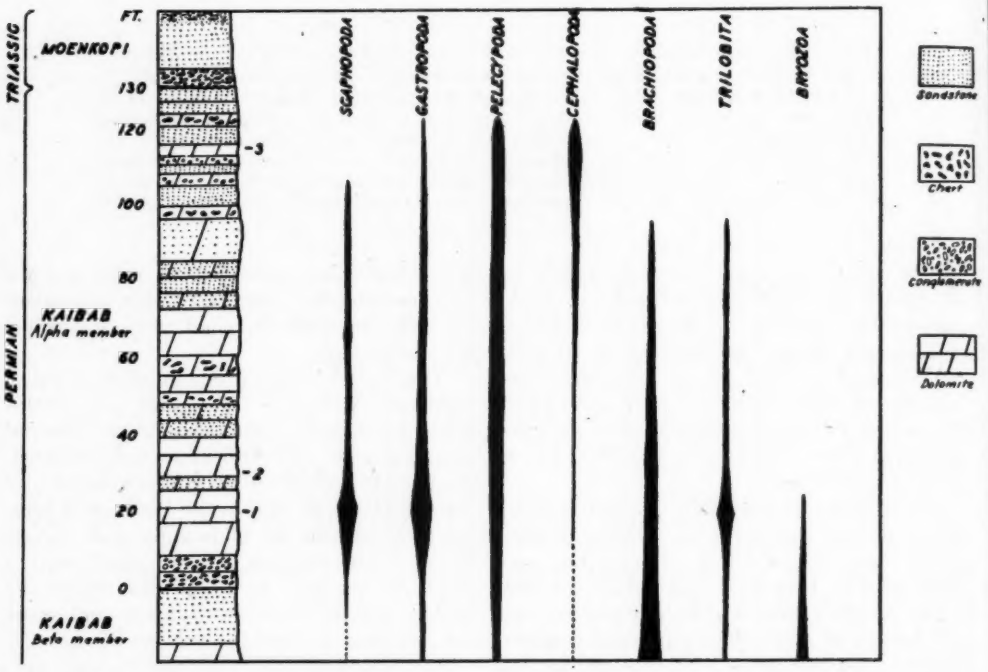


FIG. 1.—Generalized section of the Alpha member of the Kaibab formation at Flagstaff, Arizona, showing the relative range and abundance of several animal groups.

METHODS

The three faunules recognized were collected from the following localities and stratigraphic horizons:

1. *Plagioglypta Faunule.*—Five miles east of Flagstaff, south of Santa Fe railroad, a few yards south of Bottomless Pits. Stratigraphic position: facies 3 of Alpha member of Kaibab formation, approximately 110 feet below base of Moenkopi formation. Lithology: fine-grained, tan dolo-

mite containing abundant fine detrital grains, (silt 7.55 percent according to L. F. Brady). Faunule: dominated by scaphopod genus *Plagioglypta*.

2. *Dictyoclostus Faunule.*—One-fourth mile southeast of Bottomless Pits in old railroad cut at base of cliff bordering east side of valley. Stratigraphic position: facies 3 of Alpha member of Kaibab formation, about 100 feet below base of Moenkopi formation. Lithology: fine-grained, light grey dolomite with red and brown iron oxide strains, containing less fine detrital sediment than rock from *Plagioglypta* zonule (silt 4.70 percent according to L. F. Brady). Faunule: dominated by brachiopod genus *Dictyoclostus*.

3. *Schizodus Faunule.*—Crest of hill ¼ mile east of Lake Mary road about 2½ miles southwest of Flagstaff, where pipe line turns northeast and leaves road. Stratigraphic position: facies 3 of Alpha member of Kaibab formation, about 15 feet below Moenkopi formation. Lithology: fine-grained, hard, reddish brown dolomite (silt less than in *Plagioglypta* and *Dictyoclostus* zonules). Faunule: dominated by pelecypod genus *Schizodus*.

Each of the faunules was sampled to determine the relative abundance of the genera contained therein. Two blocks of rock from the *Plagioglypta* zonule with dimensions 14 by 12 by 11 inches and 8 by 8 by 6 inches were broken up and recognizable specimens of each genus identified and counted. Three rocks containing the *Dictyoclostus* faunule were broken up and the genera counted. Dimensions of these blocks were 8 by 7 by 7 inches, 6 by 6 by 5 inches, and 6 by 6 by 4 inches. Several slabs of rock taken from the zonule containing the *Schizodus* faunule were also examined and the number of genera counted. The dimensions of the slabs were as follows: 14 by 11 inches, 12 by 10 inches, 12 by 6 inches, 10 by 9 inches, 10 by 7 inches, 8 by 4 inches, 6 by 4 inches. The number of specimens representing each is listed in table 1.

TABLE 1. LIST OF GENERA AND NUMBER OF TIMES A GENUS WAS RECOGNIZED

Genera	Faunules 1.	2.	3.
MOLLUSCA			
SCAPHOPODA			
Plagioglypta	41	9	
GASTROPODA			
Bellerophon	21	12	
Euphemites	32	23	
Murchisonia	5	18	2
Naticopsis	1	2	
Euomphalus	3	2	
Soleniscus	1		
Baylea		3	
PELECYPODA			
Schizodus	1	1	30
Nuculopsis	8	14	6
Nuculana		4	
Parallelodon	8	12	
Pleurophorus	24	9	10
Dozierella	8	6	2
Myalina	5	2	10
Allorisma	3	1	
Edmondia	2	5	
Astartella	11	7	
PELECYPODA			
Solenomorpha	2		
Janeia	1		
Aviculopecten	3	3	
CEPHALOPODA			
Metacoceras			3
Aulometacoceras			1
Tainoceras			1
BRACHIOPODA			
Dictyoclostus	7	11	
Marginifera	6	7	
Chonetes	5		
ARTHROPODA			
TRILOBITA			
Anisopyge	6	1	
BRYOZOA			
Poorly preserved fragment	1		
ANNELIDA			
Worm tubes on specimen of *Marginifera*		1	

ANALYSIS OF THE FAUNULES

The relative abundance of various animal groups in the Alpha member is shown in figure 1. Such groups as sponges and echinoderms, although they occur in the Beta member, were not found in the Alpha member. The bryozoa occur only as poorly preserved specimens in the lower part of the Alpha member. From their condition and sparse occurrence, it is possible that they were washed into the deposits.

It is apparent from figure 1 and from table 1 that there is a general tendency to-

ward progressive depauperization of successive faunules in the Alpha member of the Kaibab formation.

Differences between the lower two faunules, which are only 10 feet apart stratigraphically, are not great and may be due to the larger amount of fine detrital sediment in the *Plagioglypta* zonule. Because of the muddy bottom, such mud dwellers as *Plagioglypta* found this habitat favorable. It may also explain why the trilobite genus *Anisopyge* is so much more abundant in the *Plagioglypta* faunule, but the lesser amount of fine sediment is hardly a satisfactory explanation for the absence of *Chonetes* in the *Dictyloclostus* faunule. The *Schizodus* faunule, 15 feet below the contact of the Moenkopi and Kaibab formations, is strikingly different from the lower faunules. Brachiopods are entirely absent and trilobites also appear to have been unable to withstand the more extreme conditions. Such genera as *Bellerophon* and *Euphemites*, which were abundant in the two lower faunules, are absent, and only one gastropod genus, *Murchisonia*, occurs. *Plagioglypta* also is no longer represented, and most of the pelecypod genera have disappeared. Among the latter group only *Nuculopsis*, *Pleurophorus*, *Dozierella*, *Myalina* and *Schizodus* remain, but the last genus is abundantly represented and seems to have flourished in this habitat. Decreased competition from other forms of life may partly explain its abundance. McKee (1938, p. 143) has described a 3 foot bed near the top of the Alpha member of the Permian Toroweap formation containing many millions of *Schizodus* shells. Along 72 miles of outcrop no other fossils were found.

Another striking element in the *Schizodus* faunule is the abundant nautiloids. In the lower part of the Alpha member, and throughout the Beta member, they occur sparingly or not at all. McKee (1938, p. 165) cites only three questionable occurrences in the Beta member. It is somewhat surprising to find the nautiloids more abundant in the restrictive environmental conditions of the Alpha member. Nautiloids are well represented in a similar environment in the Dog Creek and Blaine formations but are not reported from the Whitehorse sandstone by Newell. From the sporadic occurrence and the condition of the specimens collected, however, the writer believes that nautiloids, like bryozoans, were washed into a near shore environment by waves or currents.

Another method of analyzing the faunules, as suggested by Walther (1927, pp. 55–83), is to separate their elements into such groups as faziesfossilien, leitfossilien, and dauerfossilien. Dunbar (1941, p. 328) noted the provincial character of some faunas characterized by relict genera and species restricted in their geographic range. An excellent example of a relict genus in the Kaibab formation is the trilobite *Anisopyge*.

Most of the fossils from the three faunules may be classed as facies fossils. These, like the provincial types, are not good guides. The scaphopod *Plagioglypta*, all the gastropod genera, and all the pelecypods except *Aviculopecten* can be included among the facies fossils.

The brachiopods, the pelecypod genus *Aviculopecten*, and the nautiloids are stragglers from the open sea. These animals occur in both facies and are especially well represented in typical marine beds. They are the only good guide fossils and the age of the Alpha member of the Kaibab formation must be ascertained from them.

Taking into consideration the facies fossils, provincial fossils, and guide fossils, especially *Dictyoclostus bassi*, it is the writer's opinion that the faunules from the Alpha member of the Kaibab formation most closely resemble the fauna described by Clifton (1942) from the Blaine and Dog Creek formations of Kansas, Oklahoma, and Texas.

ACKNOWLEDGMENTS

This study was supervised by L. F. Brady and Edwin D. McKee of the Museum of Northern Arizona and Hubert G. Schenck of Stanford University. F. Haas of the Chicago Museum of Natural History gave some helpful suggestions concerning the ecology of the faunules. Konrad Krauskopf of Stanford University assisted in identifying the rock specimens. Joseph Snow of the University of Arizona identified generically the trilobite in faunules 1 and 2. To all these persons the writer expresses his sincere gratitude.

ADDENDUM

The writer has recently had the opportunity to discuss the peculiar occurrence of nautiloids in the Kaibab formation with Dr. Gayle Scott of Texas Christian University. Dr. Scott, who has studied for many years the ecological relationship of cephalopods in Pennsylvania and Permian strata of Texas, has noticed many occurrences of cephalopods under conditions which indicate shallow water and hypersalinity. He suggested that the nautiloid genera found in the upper part of the Alpha member of the Kaibab formation might also be called facies fossils which normally lived in this hypersaline environment.

Despite the worn condition of the specimens which may indicate some movement before deposition, the writer now believes that Dr. Scott's interpretation is the correct one. The distribution of the nautiloids as shown by figure 1 also adds evidence to support this contention.

BIBLIOGRAPHY

BRANSON, CARL C., 1930, Paleontology and stratigraphy of the Phosphoria formation: Missouri Univ. Studies, vol. 5, no. 2, 99 pp., 16 pls.

BUCHER, WALTER H., 1938, Key to papers published by an institute for the study of modern sediments in shallow seas: Jour. Geology, vol. 46, no. 5, pp. 726–755, 6 figs.

CLIFTON, R. L., 1942, Invertebrate faunas from the Blaine and Dog Creek formations of the Permian Leonard series: Jour. Paleontology, vol. 16, no. 6, pp. 685–699, pls. 101–104.

DUNBAR, CARL O., 1941, Permian faunas; a study in facies: Geol. Soc. America Bull., vol. 52, no. 3, pp. 313–332, 8 figs.

FENTON, CARROLL LANE and FENTON, MILDRED ADAMS, 1928, Ecologic interpretations of some biostratigraphic terms, I—faunule and zonule: Am. Midland Naturalist, vol. 11, no. 1, 23 pp.

——, 1930, Ecologic interpretations of some biostratigraphic terms, II—zone, subzone, facies, phase: idem, vol. 12, no. 5, pp. 145–153, 1 fig.

GIRTY, GEORGE G., 1908, The Guadalupian fauna: U. S. Geol. Survey Prof. Paper 58, 651 pp., 31 pls.

KING, WM., 1850, A monograph of the Permian fossils of England: Paleontographical Soc., London, Mon. 3, pt. 1, 258 pp., 28 pls.

KNIGHT, J. BROOKES, 1941, Paleozoic gastropod genotypes: Geol. Soc. America Special Paper 32, 510 pp., 96 pls., 32 figs.

MACGINITIE, G. E., 1935, Ecological aspects of a California marine estuary: Am. Midland Naturalist, vol. 16, no. 5, pp. 629–765, 21 figs.

MCKEE, EDWIN D., 1938, Environment and history of the Toroweap and Kaibab formations of northern Arizona and southern Utah: Carnegie Inst. Washington Pub. 492, 268 pp., 48 pls., 35 figs.

——, 1943, Some stratigraphic principles illustrated by Paleozoic deposits of northern Arizona: Am. Jour. Sci., vol. 241, no. 2, pp. 101–108, 2 figs.

MILLER, A. K. and FURNISH, W. M., 1937, Paleoecology of the Paleozoic Cephalopoda: Report of the Committee on Paleoecology 1936–37, National Research Council, pp. 54–63.

MILLER, A. K. and UNKLESBAY, A. G., 1942, Permian nautiloids from western United States: Jour. Paleontology, vol. 16, no. 6, pp. 719–738, pls. 111–117, 4 figs.

NEWELL, NORMAN D., 1937, Late Paleozoic pelecypods; Pectinacea: Kansas Geol. Survey Bull., vol. 10, 123 pp., 20 pls., 42 figs.

——, 1940, Invertebrate fauna of the late Permian Whitehorse sandstone: Geol. Soc. America Bull., vol. 51, no. 2, pp. 261–336, 10 pls., 11 figs.

PHILIPPI, E., 1907, Ueber Dolomitbildung und chemische Abscheidung von Kalk in heutigen Meeren: Neues Jahrb. für Mineralogie, Festband, pp. 397–445.

SCHENCK, H. G. and MULLER, S. W., 1941, Stratigraphic terminology: Geol. Soc. America Bull. vol. 52, no. 9, pp. 1419–1426, 2 tab.

STOYANOW, A., 1942, Paleozoic paleogeography of Arizona: Geol. Soc. America Bull., vol. 53, no. 9, pp. 1255–1282, 5 pls., 3 figs.

WALTHER, J., 1927, Allgemeine Palaeontologie, Borntraeger, Berlin, 809 pp.

WASMUND, E., 1926, Biocoenose und thanatocoenose: Archiv für Hydrobiologie, Band 17, Heft 1, 116 pp., 4 pls., 6 figs.

WILLIAMS, H. S., 1903, The correlation of geological faunas: U. S. Geol. Survey Bull. 210, 145 pp.

WHITE, C. A., 1879, Conditions of preservation of intertebrate fossils: U. S. Geol. Geog. Survey Terr. Bull. 5, pp. 133–141.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, PP. 558–559, NOVEMBER 1944

PALEONTOLOGICAL NOTES

AUTHORSHIP AND GENOTYPE OF SCHIZODUS, A LATE PALEOZOIC PELECYPOD

DAVID NICOL
Stanford University, California

ABSTRACT—The genus *Schizodus* Murchison and De Verneuil, 1844, has as its genotype *Axinus obscurus* Sowerby, 1823, by subsequent designation of De Verneuil, 1845.

IN THE YEAR 1844 there appeared two papers which gave a brief definition of the genus *Schizodus*, one by King in The Annals and Magazine of Natural History and the other by Murchison and De Verneuil in the Bulletin de la Société Géologique de France. King's article is clearly dated November, 1844, whereas Murchison and De Verneuil's paper was read at the "Séance du 3 Juin 1844." Internal evidence suggests that a printed account of each séance appeared in these early issues of the Bulletin de la Société Géologique de France about two months after each meeting, which would mean that this paper was published sometime in September, 1844. Further evidence for the priority of Murchison and De Verneuil's article is that their paper was reviewed in the Neues Jahrbuch for 1844 while King's article was not reviewed in the Jahrbuch until the year 1845. It would thus seem established that Murchison and De Verneuil's paper was published about two months earlier than King's.

Despite the above evidence King is usually given unquestioned authorship of the genus *Schizodus*. It is true that Murchison and De Verneuil make the following statements (p. 485, footnote and p. 505, table):

> M. King, ayant observé que la coquille permienne nommée *Axinus* par Sowerby, différait essentiellement de l'*Axinus* tertiaire qui a servi de type pour l'établissment du genre, propose, pour la première le nom de *Schizodus*. Voir sa monographie sus-mentionée. [King's monograph, however, was not published until 1850.]
>
> Persuadé que l'*Axinus* du magnesian limestone diffère essentiellement de l'*Axinus angulatus* du London clay, M. King, propose le nouveau nom générique de *Schizodus*.

The question then arises; are these statements sufficient proof that King is the real author of the genus *Schizodus?*

Article 21 of the International Rules of Zoological Nomenclature states:

> The author of a scientific name is that person who first publishes the name in connection with an indication, a definition, or a description, unless it is clear from the contents of the publication that some other person is responsible for said name *AND* its indication, definition, or description.

The point to be decided is whether or not King can be considered to have published the generic name of *Schizodus* in the paper by Murchison and De Verneuil. Nowhere in the two declarations made by Murchison and De Verneuil is credit given to King for the statements on the genus *Schizodus* actually written in their paper. They merely mention King's observations and ideas concerning the Axinuses of the Magnesian limestone. Thus, unfortunately, credit for the name *Schizodus* must be given to Murchison and De Verneuil rather than King.

In 1845 De Verneuil also attempted to give King credit for selecting the genotype as a statement below will show. Again De Verneuil does not definitely prove that King wrote this paragraph or even that it was directly copied from King's manuscript. Five years later, when King published the work, he selected a different species of *Schizodus* as genotype from the one earlier designated by De Verneuil.

There has been a difference of opinion as to which species is the genotype of *Schizodus*. King described the species *S. truncatus* in 1850 (p. 193) and selected it as the genotype (p. 185). This species must be ruled out, as several writers have done, because *S. truncatus* was a nomen nudum for six years after the genus was first proposed. Most paleontologists have supposed that *S.*

schlotheimi was the genotype, although a few have cited *S. obscurus*. Murchison and De Verneuil (1844, pp. 505, 506) list 10 species as belonging to the genus *Schizodus: S. obscurus, S. parallelus, S. truncatus, S. schlotheimi, S. rossicus, S. rotundatus, S. parvus, S. undatus, S. pusillus, S. truncatus,* and *S. minimus*. Three species, *S. parallelus, S. truncatus, S. rossicus* were at this time nomina nuda and can not be considered further. This leaves seven logical candidates for the genotype of *Schizodus*, one of which was designated by De Verneuil in 1845 (Géologie de la Russie d'Europe, footnote, p. 308) as follows:

> Le genre *Axinus* Sow., renfermant deux coquilles fort différent, M. King, conservateur du Muséum de Newcastle, propose de faire de l'*A. obscurus* le type d'un genre nouveau, dans lequel viendront se ranger plusieurs espèces assez mal classées jusqu'à présent. La caractéristique de ce nouveau genre, ainsi que les remarques générales qui la suivent, sont empruntées à un travail mansucrit sur les fossiles du magnesian limestone du comté de Durham que M. King a bien voulu nous communiquer. Le genre *Schizodus* paraît ne renfermer que des espèces des systèmes carbonifère ou permien.

De Verneuil states clearly that *Axinus obscurus* Sowerby (Vol. IV, 1823, p. 12, pl. 314) is the type of the genus *Schizodus*. According to Sowerby, *Axinus obscurus* is supposed to have been collected from the Magnesian limestone of England, from such localities as Garforth Cliff quarry, near Leeds, from Selby, from a road side one mile northwest of Pontefract, and from Westbridge (Wentbridge?) Hill. All of these localities are in, or bordering on, the Magnesian limestone as is shown on a modern geologic map of this area.

The genus *Schizodus* is commonly encountered in strata of Permian age, but it has been reported occasionally also from the Carboniferous. *Schizodus* is important to paleontologists and stratigraphers alike because these pelecypods thrived under environmental conditions that were adverse to most other forms of life. Specimens are extremely abundant in strata deposited near shore in land-locked and often somewhat hypersaline seas. Species of *Schizodus* are found all over the world in dolomite, sandy dolomite, and rock of similar composition. These strata are often adjacent to "red beds" and deposits of gypsum.

The fact that we must consider *Schizodus obscurus* from the English Magnesian limestone as the genotype and not, as usually supposed, *S. schlotheimi* from the German Zechstein fortunately does not alter the morphologic concept of the genus.

BIBLIOGRAPHY

KING, WM., 1844, On a new genus of Paleozoic shells: Annals and Mag. Nat. Hist., vol. 14, no. 92 (November, 1844), pp. 313–317.

——, 1845, *Allorisma*, ein neues paläozoiches Muschel-Geschlecht: Neues Jahrb. für Mineralogie, pp. 254, 255.

——, 1850, A monograph of the Permian fossils of England: Paleontographical Soc., London, 258 pp., 28 pls.

MURCHISON, R. I. and VERNEUIL, E. DE. 1844, Note sur les équivalents du système permien en Europe, suivie d'un coup d'oeil général sur l'ensemble de ses fossiles, et d'un tableau des espèces: Bull. de la Soc. Géol. de France, 2me série, tome 1 (Séance du 3 Juin, 1844), pp. 475–517.

——, 1844, Note über die Äquivalente des Permischen Systems in Europa und Übersicht seiner fossilen Arten: Neues Jahrb. für Mineralogie, pp. 732–739.

MURCHISON, R. I., VERNEUIL, É. DE and KEYSERLING, A. DE, 1845, Géologie de la Russie d'Europe et des Montagnes de l'Oural: vol. 2, pt. 3, paléontologie, 512 pp., 50 pls.

SCHENK, E. T. and MCMASTERS, J. H., 1936, Procedure in taxonomy: Stanford Univ. Press, 72 pp.

SOWERBY, JAMES, 1823, The mineral conchology of Great Britain: vol. 4, 160 pp., pls. 307–407.

JOURNAL OF PALEONTOLOGY, VOL. 18, NO. 6, P. 560, NOVEMBER 1944

NEW NAMES FOR TWO FORAMINIFERAL HOMONYMS

HELEN TAPPAN[1]
Tulane University, New Orleans, Louisiana

New names are here proposed for two species of Foraminifera described in 1940. These homonyms were brought to my attention by Dr. Hans E. Thalmann (1943).

Ammobaculites dentonensis Tappan, new name, is proposed for *Ammobaculites variabilis* Tappan, 1940 (not *Ammobaculites variabilis* (Brady), 1884). Brady's species was described as a *Verneuilina*, but belongs to *Ammobaculites*, according to Franke, 1928. *A. dentonensis* Tappan was also referred by me to *A. variabilis* Tappan in a discussion of the species in 1943.

Nodosaria graysonensis Tappan, new name, is proposed for *Nodosaria bifurcata* Tappan, 1940 (not *Nodosaria* (*Dentalina*) *bifurcata* d'Orbigny, 1846).

REFERENCES

FRANKE, A., 1928, Die Foraminiferen der Oberen Kreide Nord- und Mitteldeutschlands: Preuss. Geol. Landesanst., Abh., n. ser., vol. 111, p. 166, pl. 15, fig. 6.

TAPPAN, HELEN, 1940, Foraminifera from the Grayson formation of northern Texas: Jour. Paleontology, vol. 14, no. 2, pp. 97, 103, pl. 14, figs. 12a-b, pl. 16, figs. 5a-b.

TAPPAN, HELEN, 1943, Foraminifera from the Duck Creek formation of Oklahoma and Texas: Jour. Paleontology, vol. 17, no. 5, p. 482, pl. 77, fig. 8.

THALMANN, HANS E., 1943, Bibliography and index to new genera, species and varieties of foraminifera for the year 1940: Jour. Paleontology, vol. 17, no. 4, pp. 388–408.

[1] Mrs. Alfred R. Loeblich, Jr.

REKLAW OSTRACODA, A CORRECTION

MORTON B. STEPHENSON
Stanolind Oil and Gas Company, Houston, Texas

In an earlier issue of this Journal (vol. 16, pp. 482–483, 1942), I described the new ostracode *Cytheridea* (*Haplocytheridea*) *stenzeli* Stephenson, and in a subsequent number (vol. 18, pp. 448–454, 1944) amplified the ostracode fauna accompanying the species. The material came from an outcrop of the Reklaw Eocene on Ridge Creek, Bastrop County, Texas. Through an oversight, I failed to indicate in the latter paper that the location and identification of this locality was based on the field work of Dr. H. B. Stenzel of Austin, Texas. The importance of this exposure, which was correctly placed stratigraphically in the field by Dr. Stenzel, cannot be too strongly emphasized. Outcrops of marine Claiborne Eocene strata in Texas are most infrequent, and many of the better known localities have been assigned erroneous age determinations. The tireless work of Dr. Stenzel has made him an outstanding authority on the Tertiary stratigraphy of Texas. A knowledge of this fossiliferous lower Claiborne locality and its identification constitute an important advance in the complex problem of correlation of the Eocene sediments of the Gulf Coastal Plain. My sincere appreciation is extended to Dr. Stenzel for his kindness in allowing me to publish on his new locality.

DISTRIBUTION OF ESCHAROPORA HOGBENI FRITZ

MARSHALL KAY
Columbia University, New York, N. Y.

Professor M. A. Fritz (1944) recently described a distinctive bryozoan, *Escharopora hogbeni*, the only known specimens being from the Hull limestone at Hull, Quebec. The species has wide geographic distribution. It is present in the Kirkfield ("Hull")

limestone at Shannonville, Ontario, near Lake Ontario (Kay, 1942, as "*Escharopora* n. sp."), and in the same formation in dolomitized limestone dredged from Neebish channel, St. Mary's River, dumped south of Neebish Island ferry wharf, Chippewa County, Michigan. Sinclair (1942) has discussed the nomenclature and correlation of the Hull and Kirkfield formations; the writer believes them equivalent (Kay, 1943).

REFERENCES

FRITZ, M. A., 1944, Jour. Paleontology, vol. 18, no. 3, pp. 263–264.

KAY, MARSHALL, 1942, Geol. Soc. America Bull., vol. 53, no. 4, p. 606.

——, 1943, Am. Jour. Sci., vol. 241, no. 10, p. 599.

SINCLAIR, G. W., 1942, Geol. Soc. America Bull., vol. 53, no. 12, pt. 2, p. 1833.

JOURNAL OF PALEONTOLOGY
INDEX TO VOLUME 18

AUTHOR INDEX

		No.	Page
1.	AGNEW, ALLEN F., Addenda and errata to bibliography of Paleozoic ostracodes	(2)	218
2.	BANDY, O. L., Eocene Foraminifera from Cape Blanco, Oregon	(4)	366
3.	BARKER, R. WRIGHT, Some larger Foraminifera from the Lower Cretaceous of Texas	(2)	204
4.	BASSLER, R. S., *Parafavosites* and similar tabulate corals	(1)	42
5.	BERQUIST, HARLAN R., Cretaceous of the Mesabi Iron Range, Minnesota	(1)	1
6.	COLBERT, EDWIN H., Corrections for a "check list of fossil reptiles of New Jersey" by William F. Rapp	(5)	480
7.	COMPTON, ROBERT R., A new Paleocene gastropod from southern California	(5)	464
8.	CONDRA, G. E., and ELIAS, M. K., Occurrence of the Russian genus *Rhombotrypella* in Utah	(2)	148
9.	CONDRA, G. E., and ELIAS, M. K., *Hederella* and *Corynotrypa*	(6)	535
10.	COOPER, CHALMER L., Smaller Foraminifera from the Porters Creek formation (Paleocene) of Illinois	(4)	343
11.	CUSHMAN, J. A., and DEADERICK, W. H., Cretaceous Foraminifera from the Marlbrook marl of Arkansas	(4)	328
12.	CUSHMAN, JOSEPH A., and SIMONSON, RUSSELL R., Foraminifera from the Tumey formation, Fresno County, California	(2)	186
13.	DAVID, LORE R., A Permian shark from the Grand Canyon	(1)	90
	DEADERICK, W. H., see CUSHMAN, J. A. (11)		
14.	DECKER, CHARLES E., Pendent graptolites of Arkansas, Oklahoma and Texas	(4)	378
15.	DENHAM, R. L., Conodonts	(2)	216
16.	EASTON, WM. H., Revision of *Campophyllum* in North America	(2)	119
17.	EASTON, WM. H., Review of "Study and revision of *Archimedes* (Hall)" by G. E. Condra and M. K. Elias	(4)	405
18.	EDWARDS, RICHARD A., Ostracoda from the Dublin marl (upper Miocene) of North Carolina	(6)	505
19.	ELIAS, MAXIM K., Auloporidae and Hederelloidea	(6)	529
	ELIAS, MAXIM K., see CONDRA, G. E. (8, 9)		
20.	ELLISON, SAMUEL, Composition of conodonts	(2)	133
21.	FRANKLIN, E. S., Microfauna from the Carapita formation of Venezuela	(4)	301
22.	FRITZ, MADELEINE A., Upper Devonian Bryozoa from New Mexico	(1)	31
23.	FRITZ, MADELEINE A., The Hull bryozoan *Escharopora hogbeni*	(3)	263
24.	HAAS, OTTO, Hystatoceratidae or Dipoloceratidae?	(1)	94
25.	HAAS, OTTO, "Upper Albian ammonite from . . . New Mexico," a Turonian *Prionocyclus*	(3)	289
	HAAS, OTTO, see VOKES, H. E. (59)		
26.	HOUGH, MARGARET JEAN, The auditory region in some Miocene carnivores	(5)	470
	HOWELL, B. F., see RUEDEMANN, RUDOLPH (41)		
27.	HUDSON, R. G. S., Lower Carboniferous corals of the genera *Rotiphyllum* and *Permia*	(4)	355
28.	KEEN, A. MYRA, Catalogue and revision of the gastropod subfamily Typhinae	(1)	50
29.	KOSANKE, R. M., Review of "An introduction to pollen analysis" by G. Erdtman	(4)	409
30.	LEITH, E. I., *Halysites gracilis* from the Ordovician of Manitoba	(3)	268
31.	MILLER, A. K., and OWEN, JOHN BRITTS, The cephalopod fauna of the Pennsylvanian Union Valley formation of Oklahoma	(5)	417
32.	MILLER, A. K., and UNKLESBAY, A. G., Trilobite genera *Goldius* and *Arctinurus* in the Silurian of Iowa and Illinois	(4)	363
	MILLER, A. K., see THOMPSON, M. L. (58)		
33.	MONSOUR, EDWARD, Fossil corals of the genus *Turbinolia* from the Gulf Coast	(2)	109
34.	NEWELL, NORMAN D., and TAFUR, ISAAC, Fossiliferous Ordovician in lowlands of eastern Peru	(6)	540
35.	NICOL, DAVID, New West American species of the foraminiferal genus *Elphidium*	(2)	172
36.	NICOL, DAVID, Paleocology of three faunules from the Permian Kaibab formation at Flagstaff, Arizona	(6)	553
37.	NICOL, DAVID, Authorship and genotype of *Schizodus*, a Late Paleozoic pelecypod	(6)	558
	OWEN, JOHN BRITTS, see MILLER, A. K. (31)		
38.	RASETTI, FRANCO, Upper Cambrian trilobites from the Lévis conglomerate	(3)	229

39. RICHARDS, HORACE, G., Review of "Eocene of Virginia" by Benjamin Gildersleeve.. (4) 409
40. RAAP, WILLIAM F., JR., Check list of fossil reptiles of New Jersey.....(3, 6) 285
41. RUEDEMANN, RUDOLPH, and HOWELL, B. F., Impression of a worm on the test of a Cambrian trilobite..... (1) 96
42. SCHENCK, HUBERT G., *Lamellinucula*, a new subgenus of nuculoid pelecypods..... (1) 97
43. SCHENCK, HUBERT G., Review of "The bulletin of zoological nomenclature" edited by Francis Hemming..... (2) 220
44. SCHENCK, HUBERT G., Proloculus in Foraminifera..... (3) 275
45. SCOTT, HAROLD W., Permian and Pennsylvanian fresh-water ostracodes..... (2) 141
46. SCOTT, HAROLD W., Muscle-scar patterns on some upper Paleozoic ostracodes..... (2) 162
SIMONSON, RUSSELL R., see CUSHMAN, JOSEPH A. (12)
47. STENZEL, H. B., A new Paleocene catometope crab from Texas, *Tehuacana tehuacana* (6) 546
48. STENZEL, H. B., A new Cretaceous crab, *Graptocarcinus muiri*, from Mexico..... (6) 550
49. STEPHENSON, MORTON B., New Ostracoda from subsurface Middle Tertiary strata of Texas..... (2) 156
50. STEPHENSON, MORTON B., Ostracoda from the Reklaw Eocene of Bastrop County, Texas..... (5) 448
51. STEPHENSON, MORTON B., Reklaw Ostracoda, a correction..... (6) 560
52. STIRTON, R. A., A rhinoceros tooth from the Clarno Eocene of Oregon..... (3) 265
TAFUR, ISAAC, see NEWELL, NORMAN D. (34)
53. TAPPAN, HELEN, New names for two foraminiferal homonyms..... (6) 560
54. TEICHERT, CURT, The genus *Aturia* in the Tertiary of Australia..... (1) 73
55. TEICHERT, CURT, Two new ammonoids from the Permian of Western Australia.... (1) 83
56. TEICHERT, CURT, Permian trilobites from Western Australia..... (5) 455
57. THALMANN, HANS E., Bibliography and index to new genera, species and varieties of Foraminifera for the year 1941..... (4) 387
58. THOMPSON, M. L., and MILLER, A. K., The Permian of southern-most Mexico and its fusulinid faunas..... (6) 481
UNKLESBAY, A. J., see MILLER, A. K. (32)
59. VOKES, H. E., and HAAS, OTTO, South American and European species of *Spondylospira*..... (3) 283
60. WELLER, J. MARVIN, Review of "Stratigraphy of the eastern and central United States" by Charles Schuchert..... (2) 220
61. WELLER, J. MARVIN, Permian trilobite genera..... (4) 320
62. WELLER, J. MARVIN, Review of "Review of petroleum geology in 1943" by F. M. Van Tuyl and others..... (4) 410
63. WELLS, JOHN W., A new coral from the Buda limestone (Cenomanian) of Texas... (1) 100
64. WELLS, JOHN W., New tabulate corals from the Pennsylvanian of Texas..... (3) 259
65. WELLS, JOHN W., Cretaceous, Tertiary and Recent corals, a sponge, and an alga from Venezuela..... (5) 429
66. WHITMORE, FRANK C., JR., Machine for serial sectioning of fossils..... (2) 210
67. WILSON, JOHN ANDREW, An *Amebelodon* from Malheur County, Oregon..... (3) 271
68. YEN, TENG-CHIEN, Notes on fresh-water mollusks of Idaho formation at Hammett, Idaho..... (1) 101

SUBJECT INDEX

Ammonites: Australian Permian (55); Cretaceous (25); Hystaloceratidae or Diploceratidae? (24).
Algae: Cretaceous from Venezuela (65).
Arkansas: Cretaceous Foraminifera (11); Ordovician graptolites (14).
Arizona: Permian paleoecology (36); Permian shark (13).
Australia: Permian ammonite (55); Permian trilobites (56); Tertiary cephalopod (54).
Brachiopods: *Spondylospira* of South America and Europe (59).
Bryozoans: Auloporidae and Hederelloidea (19); Devonian from New Mexico (22); *Hederella* and *Corynotrypa* (9); *Rhombotrypella* in Utah (8); Trenton of Quebec (23).
California: Eocene Foraminifera (12); Paleocene gastropod (7).
Cambrian: Trilobites (38); worm impression (41).
Carboniferous: Corals from England (27).
Cephalopods: Australian Tertiary (54); Permian of Oklahoma (31).
Conodonts: Composition (20); relationship (15).
Corals: Cenomanian of Texas (63); Gulf Coast Tertiary (33); Lower Carboniferous of England (27); Ordovician of Manitoba (30); Pennsylvanian of Texas (64); revision of *Campophyllum* (16); Silurian (4); Tertiary and Recent from Venezuela (65).
Cretaceous: Coral from Texas (63); crab from Mexico (48); fauna in Minnesota (5); Foraminifera from Arkansas (11); Foraminifera from Texas (3); sponge and alga from Venezuela (65); Turonian ammonite (25).
Crustaceans: Cretaceous crab (48); Paleocene crab (47).

Devonian: Bryozoa from New Mexico (22).
England: Lower Carboniferous corals (27).
Eocene: Foraminifera from Oregon (2); Ostracoda from Texas (50); rhinoceros tooth from Oregon (52).
Europe: Species of *Spondylospira* (59).
Foraminifera: Bibliography for 1941 (57); Cretaceous of Arkansas (11); Cretaceous of Texas (3); *Elphidium* (35); Eocene of Oregon (2); new names (53); Oligocene of California (12); Oligocene from Venezuela (21); Paleocene of Illinois (10); proloculus (44).
Fusulines: Permian of Mexico (58).
Gastropods: Idaho formation (68); Paleocene of California (7); subfamily Typhinae (28).
Graptolites: Ordovician of Arkansas, Oklahoma and Texas (14).
Idaho: Fresh-water mollusks (68).
Illinois: Paleocene Foraminifera (10); Silurian trilobites (32).
Iowa: Silurian trilobites (32).
Jurassic: *Spondylospira* of South America and Europe (59).
Manitoba: Ordovician corals (30).
Members: Paleontological Society (3) 290; Society of Economic Paleontologists and Mineralogists (2) 222.
Mexico: Cretaceous crab (48); Permian fusulines (58).
Minnesota: Cretaceous fauna (5).
Miocene: Carnivores (26); Ostracoda from North Carolina (18).
New Mexico: Devonian bryozoa (22).
North Carolina: Miocene Ostracoda (18).
Oklahoma: Ordovician graptolites (14); Pennsylvanian cephalopods (31).
Oligocene: California Foraminifera (12); Foraminifera from Venezuela (21).
Oregon: Eocene Foraminifera (2); Eocene rhinoceros tooth (52); Pliocene *Amebelodon* (67).
Ordovician: Bryozoan of Quebec (23); corals of Manitoba (30); fossils from Peru (34); graptolites from Arkansas, Oklahoma and Texas (14).
Ostracodes: Bibliography (1); Eocene (51); Eocene of Texas (50); fresh-water from Permian and Pennsylvanian (45); Miocene of North Carolina (18); muscle-scar patterns (46); Tertiary of Texas (49).
Paleocene: Crab from Texas (47); Foraminifera from Illinois (10); gastropod from California (7).
Paleoecology: Permian of Arizona (36).
Pelecypods: *Lamellinucula* (42); *Schizodus* (37).
Pleistocene: Foraminifera (35).
Pliocene: *Amebelodon* from Oregon (67).
Pennsylvanian: Bryozoans (9); cephalopods from Oklahoma (31); corals of Texas (64); fresh-water ostracodes (45); ostracode muscle scars (46).
Permian: Ammonite from Australia (55); fresh-water ostracodes (45); Permian fusulines of Mexico (58); ostracode muscle scars (46); paleoecology (36); shark from Arizona (13); trilobites (61); trilobites from Australia (56).
Quebec: Trenton bryozoan (23); Upper Cambrian trilobites (38).
Recent: Corals from Venezuela (65); Foraminifera (35).
Siberia: Silurian corals (4).
Silurian: Tabulate corals (4); trilobites of Iowa and Illinois (32).
Society records and activities (S.E.P.M.), page 411.
South America: Cretaceous, Tertiary and Recent corals, a sponge, and alga from Venezuela (65); Foraminifera from Venezuela (21); fossiliferous Ordovician of eastern Peru (34); species of *Spondylospira* (59).
Sponges: Cretaceous of Venezuela (65).
Tertiary: Cephalopod *Aturia* (54); corals from Gulf Coast (33); corals from Venezuela (65); Ostracoda from Texas (49).
Texas: Cenomanian coral (63); Cretaceous Foraminifera (3); Eocene Ostracoda (50); Ordovician graptolites (14); Paleocene crab (47); Pennsylvanian corals (64); Tertiary Ostracoda (49).
Trilobites: Permian of Australia (56); Permian genera (61); Silurian of Iowa and Illinois (32); Upper Cambrian (38).
Utah: *Rhombotrypella* (8).
Vermes: Cambrian (41).
Vertebrates: Eocene rhinoceros tooth (52); fossil reptiles of New Jersey (40); Miocene carnivores (26); Permian shark (13); Pliocene *Amebelodon* from Oregon (67).

OFFICERS OF THE SOCIETIES

THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

For the year ending March 1945

President, DONALD D. HUGHES, Stanford University, Calif.

First Past-President, J. HARLAN JOHNSON, Golden, Colo.

Second Past-President, HERSCHEL L. DRIVER, Los Angeles, Calif.

Vice-President, HERSHAL C. FERGUSON, Houston, Tex.

Secretary-Treasurer, H. B. STENZEL, Austin, Tex.

Editor, J. MARVIN WELLER, Urbana, Ill.

THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

For the year ending March 1945

President, IRA H. CRAM, Chicago, Ill.

Past-President, A. RODGER DENISON, Tulsa, Okla.

Vice-President, WARREN B. WEEKS, Shreveport, La.

Secretary-Treasurer, ROBERT E. RETTGER, Dallas, Tex.

Editor, GAYLE SCOTT, Fort Worth, Tex.

THE PALEONTOLOGICAL SOCIETY

For the year ending December 1944

President, B. F. HOWELL, Princeton, N.J.
Vice-President, SIEMON W. MULLER, Stanford University, Calif.
Secretary, H. E. VOKES, Washington, D.C.
Treasurer, R. R. SHROCK, Cambridge, Mass.; C. O. DUNBAR (acting), New Haven, Conn.
Editor, C. WYTHE COOKE, Washington, D.C.
Chairman, Cordilleran Section, W. P. POPENOE, Pasadena, Calif.

Ex-Presidents

L. W. STEPHENSON, Washington, D.C., 1941
E. H. SELLARDS, Austin, Texas, 1942.
JOHN B. REESIDE, JR., Washington, D.C., 1943.

THE GEOLOGICAL SOCIETY OF AMERICA

For the year ending December 1944

President, ADOLPH KNOPF, New Haven, Conn.
Past-President, E. L. BRUCE, Kingston, Ont.

Vice-Presidents

E. W. BERRY, Baltimore, Md.
B. S. BUTLER, Tucson, Ariz.
JOHN B. REESIDE, JR., Washington, D.C.
JOHN F. SCHAIRER, Washington, D.C.

Secretary, H. R. ALDRICH, New York, N.Y.

Councillors

WILLIAM O. HOTCHKISS A. I. LEVORSEN ROLLIN T. CHAMBERLIN	1942–1944
JAMES GILLULY F. J. ALCOCK K. C. HEALD	1943–1945
T. M. BRODERICK W. H. BRADLEY CHESTER STOCK	1944–1946